

RECONNAISSANCE FROM CARROLL, MONTANA, TO YELLOWSTONE NATIONAL PARK.

GENERAL REPORT.

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HEADQUARTERS DEPARTMENT OF DAKOTA,
OFFICE OF CHIEF ENGINEER,
Saint Paul, Minn., February 1, 1876.

SIR: I have the honor to submit herewith my report of the reconnaissance from Carroll, Mont., to Camp Baker, thence to Fort Ellis and the Yellowstone National Park, made during the months of July, August, and September, 1875, in accordance with the instructions given in Special Orders No. 110, dated Headquarters Department of Dakota, Saint Paul, Minn., June 14, 1875.

My report includes those of Mr. George Bird Grinnell on the paleontology and zoölogy and of Mr. Edward S. Dana on the geology of the region traversed. These reports will be found highly interesting and valuable. Drawings of fossils collected by Mr. Grinnell form a portion of his report.

Lieut. R. E. Thompson's report of the trip to the Judith Basin, and of the return from Carroll to Ellis, are also submitted; Lieutenant Thompson's topographical work having been incorporated in the general map.

A map of the route pursued is presented on a scale of six miles to the inch, and a tabular statement is appended to the report, giving the astronomically-determined positions of important points, tables of distance, instrumental observations, &c.

The determinations of Forts Shaw and Ellis are those of Lieut. F. V. Greene, Corps of Engineers, who was at those posts last summer on duty connected with the United States Boundary Commission. His labors obviated the necessity for my going to Fort Shaw (which would have consumed some valuable time), and also saved me additional delay at Fort Ellis, at which place, out of six days I spent there, rain fell continuously for five.

The position of Fort Benton and the map of the Missouri River below that post are from the survey of the same officer, under direction of Capt. William J. Twining, Corps of Engineers, chief astronomer of the Boundary Commission, who with his party descended the river from Benton to Bismarck in Mackinac boats, at the close of the season's operations in 1874, carefully mapping it, and establishing almost daily astronomical stations. The river distances determined by this survey show an enormous reduction from the crude and exaggerated estimates given in existing tables, and which have heretofore been accepted as fair approximations. Above Benton, the river is from the various published authorities collated, and as far as possible reconciled.

The topography adjoining the route is from the field-notes of the reconnaissance.

Sketches of the Judith and Upper Geyser Basins are given in the body of the report, also from field-notes.

The general topography of the Yellowstone Park is mainly taken from the published maps of Dr. Hayden and Captain Jones; using, however, my own latitudes wherever good observations were taken. This, however, was but seldom, since showers fell every day but one that we were in the park, and the nights were almost invariably cloudy.

Inasmuch as no one who has seen this interesting region can fail to be deeply solicitous for its care and preservation, I am impelled to express a hope for favorable consideration from the department commander of the remarks and suggestions in relation thereto.

RECONNAISSANCE FROM CARROLL, MONTANA,

I left Saint Paul on the evening of June 30, in obedience to Special Orders No. 110, series of 1875, from headquarters Department of Dakota, and proceeded, via the Northern Pacific Railroad, to Bismarck, its western terminus, on the Missouri River.

Departure from
Saint Paul.

[Special Orders No. 110.]

HEADQUARTERS DEPARTMENT OF DAKOTA,
Saint Paul, Minn., June 14, 1875.

Capt. William Ludlow, chief engineer of the department, will, on July 1 proximo, proceed, via the Northern Pacific Railroad and the Missouri River, to Carroll, Mont., and make a reconnaissance of the route from that place to Camp Baker. Having completed this duty, he will proceed to the several posts in the district of Montana, and determine their latitudes and longitudes. He will also, if time permits, make a reconnaissance from Fort Ellis to the Yellowstone Park. Captain Ludlow is authorized to take with him his assistant and the enlisted men of engineers under his command. He is also authorized to take with him a geologist and such other scientific gentlemen, not exceeding four in all, as may desire to accompany his party. The commanding officer of the District of Montana will furnish escorts to Captain Ludlow from point to point, wherever, in his judgment, it may be necessary, sending a party to Carroll for that purpose; the transportation being sufficient to furnish one wagon, one ambulance, and five saddle-horses for use of Captain Ludlow's party.

By command of Brigadier-General Terry:

O. D. GREENE,
Assistant Adjutant-General.

[Special Orders No. 127.]

HEADQUARTERS DEPARTMENT OF DAKOTA,
Saint Paul, Minn., July 7, 1875.

III. The Quartermaster's Department will employ one civilian guide and scout to accompany the reconnaissance under Capt. William Ludlow, United States Engineers, authorized in Department Special Orders No. 110, current series. He will be paid at the rate of \$75 per month for the time he is actually employed, and will be furnished with transportation by steamboat for himself and horse from Bismarck to Carroll and return. The acting assistant quartermaster at Fort Abraham Lincoln will take him up on his "Report of persons and articles."

IV. Second Lieut. R. E. Thompson, Sixth Infantry, will report to Capt. William Ludlow, Engineer Corps, for duty as topographer, with the reconnaissance under the latter-named officer, authorized by Special Orders No. 110, current series, from these headquarters.

By command of Brigadier-General Terry:

O. D. GREENE,
Assistant Adjutant-General.

My party consisted (beside my brother, Mr. Edwin Ludlow, of New York, and assistant, Mr. W. H. Wood) of Messrs. George Bird Grinnell and Edward S. Dana, both of Yale College, who had come out to Saint Paul upon my invitation for the purpose of joining me.

Composition of the
party.

These gentlemen traveled at their own expense, receiving no compensation for their services; and

Messrs. Grinnell
and Dana as special
and uncompensated
assistants.

I cannot but consider myself extremely fortunate in having induced them to accompany me as special assistants. Mr. Grinnell would report upon the paleontology and zoölogy and Mr. Dana upon the geology of the country passed over.

The reports attest their zeal and industry, as well as the fullness of their qualifications for, and conscientious devotion to, their voluntarily-assumed tasks.

Special Orders No. 121 directed my detachment of engineer soldiers, consisting of Sergeants Becker and Wilson and five men, to report to me at Carroll for surveying purposes.

At Bismarck, the party was increased by the addition to it of Lieut. R. E. Thompson, Sixth Infantry, who was to accompany it as topographer and general assistant, and of Charles Reynolds, a well-known frontiersman, who was to act as guide and hunter for the expedition.

Lieutenant Thompson
and Charles Reynolds
added to the
party.

The instruments taken on the trip were a small Würdemann transit-theodolite, No. 94; a Spencer Browning & Co.'s sextant, No. 6536; a Gambay & Son reflecting-circle, No. 212; and two chronometers, a mean solar of Arnold & Dent, No. 1362, and a sidereal of Bond & Sons, No. 202. These instruments, with the exception of the circle, had been used on the reconnaissance to the Black Hills of the previous season, and were known to be good. In addition were four odometers, two thermometers, two aneroid barometers, and an odometer-cart, constructed for the purpose of measuring distances.

Instruments used
on the reconnaissance.

The party, after three days' detention at Bismarck, embarked on the steamer Josephine the evening of July 5, and sailed early on the morning of the 6th. Directions had been given Sergeant Becker to make a survey of the river while going up. This was continued during the day; but as night fell, and the boat continued to run, it was found impossible to take the necessary compass-bearings to points in advance.

Fort Stevenson, eighty-four miles from Bismarck, was reached at midnight. Here Lieutenant Thompson and Reynolds landed for the purpose of procuring some necessary articles, intending to join the boat again at Fort Berthold, which, although twenty-five miles above Stevenson by water, is only seven or eight miles by land.

July 7.—At 5 a. m., the boat reached Berthold, and stopped for two hours to land some freight, and Lieutenant Thompson and Reynolds again came on board. Berthold is the agency for the combined tribes of Rees, Gros Ventres, and Mandans, who occupy in common a village built on the north bank of the river, surrounding an old stockade of the Northwestern Fur Company, which had formerly a trading-post here. At that early hour, the village was still asleep, and a stroll through it resulted only in arousing the numerous Indian curs that with snarls and threatening aspect resented the intrusion.

July 8.—Was hot and uneventful. Toward afternoon, the mosquitoes became more and more troublesome, and at night forbade sleep. About 11 p. m., the boat was stopped for the purpose of landing Reynolds (who had his horse with him), and dispatching him in advance to Fort Buford, with a note to the post-quartermaster for supplies and one to the post-surgeon. A member of the party had been severely attacked with a disorder brought on by the heat and the effect of the river-water, which it is injudicious for one unaccustomed to its use to indulge in freely.

July 9.—Arrived at Buford, three hundred miles above Bismarck, at 3 a. m. The surgeon, Dr. Middleton, kindly came down at once and announced that the invalid was suffering from a sharp attack, and that it would be in a high degree dangerous for him to proceed. I made preparations at once to go ashore and remain until the next succeeding boat, which would pass in a week or ten days, should enable me to continue the journey. Meanwhile Lieutenant Thompson would be in charge of the party, and instructions were given him to proceed to Carroll and examine thoroughly the neighboring country. A full opportunity would at the same time be afforded to determine the latitude and longitude of Carroll as a starting-point for the survey of the Carroll road, thence to Camp Baker, which might then be proceeded with immediately on my arrival.

July 15.—The Josephine returned to Buford from Carroll, having safely landed the party, and brought a note from Lieutenant Thompson to the effect that the Indians had been very troublesome on the Carroll road, had run off a drove of forty mules belonging to the Transportation Company, and had even boldly invaded Carroll and attempted to steal horses from the picket-rope.

I received information also that three recruits of a large detachment which had recently gone up the river, destined for Fort Shaw, had been killed in the immediate vicinity of Camp Lewis, seventy-five miles out of Carroll.

Under the circumstances, and feeling some apprehension for the safety of the party, which had an escort of ten men only, it was weary waiting at Buford for the next boat up, the arrival of which was delayed from various causes, until I had nearly determined upon the overland trip of two hundred and seventy-five miles to Carroll, dangerous as this would have been, on account of the activity of the Indians and their large numbers in the vicinity of Fort Peck. However, the Key West at last arrived, on the morning of the 23d; and, hastily getting on board, the journey was resumed. Wolf Point, the Assiniboine agency, was reached at 10 p. m. of the 24th, and Fort Peck, the general up-river agency for the Sioux, on the evening of the 25th.

Peck, one hundred and eighty miles above Buford by water, stands on a narrow plateau of the north bank of the river, almost overhung by the hills in rear. The buildings are of logs, one story, and inclosed within a stockade. This agency is the most considerable on the Missouri River. I was informed that from 8,000 to 10,000 people were fed there.

The distance to the hostile camps of Sitting Bull on the Yellowstone is not much in excess of one hundred miles, and intercourse is easy and not infrequent. It seems more than probable that

in order to make up the large number which it is claimed is furnished with food and clothing from this agency, the Indians of the Yellowstone must be included, the attitude of whom is one of vigilant and unvarying hostility to all white men.

July 26.—Left Fort Peck at 3 a. m. Up to this point, the character of the river and its valley appeared to be measurably unchanged, a broad, rapid, and turbid stream, about three feet deep in the channel, cutting into its banks at every turn, sand-bars frequently appearing in the muddy bed; the valley heavily timbered with cottonwood, and well defined by hills. Above Peck, the bed of the stream became more gravelly, the channel consequently more stable, and the water somewhat clearer. The river narrowed to a width of from 150 to 300 yards; the clay bluffs from 150 to 600 feet in height, more closely approached the banks, and became exceedingly barren and unattractive, of dark-gray hue and ashen texture, with thin alkaline streaks near the base. Small plates of selenite scattered over the surface glittered in the sun, and the grass was exceedingly poor and scanty. As we advanced, small cedars appeared on the higher elevations, and game became more abundant. Glimpses of deer half-concealed in the shrubbery were frequently caught; large bands of elk were seen in the timbered "points;" and the shore of the river was everywhere dotted with the footprints of wild animals.

Three buffalo crossed the river in advance of the boat. One was killed and hoisted on deck; some Indians who had come on board at Wolf Point greedily appropriating the refuse portions. Just before sundown, a herd of seventy five or eighty buffalo were seen dashing down the left bank in eager pursuit of three in advance, who had already entered the water and were half-way across the stream. The herd at once plunged in, and it was soon evident that the boat would intercept them. They kept on, however; the calves, of which there were several, swimming by the lower side of the cows, and all making strenuous efforts to overtake the leaders, who had meanwhile climbed the opposite bank. The stupid animals only turned back when the foremost actually struck the boat with their heads, and then, with bovine snorts and belowings, they heaped together and climbed upon each other in desperate fright, within a few feet of us. It would have been butchery to kill them, especially as we did not need the beef, and they were allowed to escape unhurt.

July 27.—Carroll was reached at 7 p. m. I found a note from Lieutenant Thompson to the effect that the vicinity of Carroll had been examined and the necessary observations taken; and, finding that forage and rations were becoming scarce, it had been determined to proceed on the road toward Camp Baker in order to save delay.

A courier was dispatched to Camp Lewis for escort and transportation by Lieutenant-Colonel Otis, assistant inspector-general of the department, who was *en route* to Helena, and we awaited the reply.

Carroll is a frontier "town" of perhaps twenty or twenty-five log buildings, on the south bank of the river, six hundred and forty miles above Bismarck and one hundred and sixty-five miles below Fort Benton, the limit of navigation on the Upper Missouri. The town is situated on a timbered plateau 15 or 20 feet above the level of the stream at low water, in the river-valley, which is some 800 to 900 feet in depth, with steep clay slopes covered with pine. It owes its existence to its being the terminus of the road recently opened from Helena, and the point at which freights are transferred to and from the boats.

Montana has long suffered from its isolation and from the want of an outlet for its productions. Until the opening of the Carroll road, the only regular communication with the outer world was by the road from Helena to Corinne, on the Union Pacific Railroad, a distance of over four hundred and fifty miles. The distance from Helena to Carroll is more than two hundred miles less than this, a difference which, to the heavy bull-trains averaging only twelve or thirteen miles per day, represents a saving of fifteen or sixteen days in time. The Missouri River as far up as Carroll is generally navigable for the flat-bottomed stern-wheel boats that ply upon it until some time in October; and it is evident that by the aid of a connection at Bismarck with the Northern Pacific an important and valuable outlet for the wealth of the Territory has been discovered, available from the opening of navigation in the spring until quite late in the fall, a period of over five months.

In addition to the encouragement to the industries of Montana, a large saving can be made by the Government in the cost of transporting its troops and supplies for the up-river and Montana posts by the use of this route. These considerations, supported by the necessity for maintaining troops to act as a check upon the lawlessness of the large number of Indians annually congregating in the vicinity of Fort Peck, constitute an appeal to the Government to protect the road against forays by the Indians, an obligation which is recognized in the distribution of troops along the line of the road. At Camp Baker, fifty-two miles east of Helena, is a permanent garrison of two companies of infantry; at the forks of the Musselshell, fifty-six miles farther east, is a summer camp of two companies of infantry and one of cavalry; at the Judith Gap, thirty miles farther, is a detachment of eighteen or twenty men; and at Camp Lewis, thirty miles farther and seventy-five miles out of Carroll, is another summer garrison of two companies of infantry, from which a small detachment guards the stage-station at Box Elder, forty miles out of Carroll. These posts can conveniently receive their supplies from Carroll.

Military posts on the Carroll road.

If, in addition to the garrison at the forks of the Musselshell and Camp Lewis, a force of cavalry, sufficiently large to patrol the road and push reconnaissances south and east, could be established between Camp Lewis and the Judith Gap,—and in this range the requisites of wood, water, and grass are both excellent and abundant,—the route could be made as permanently safe as any other highway, and such loss of property and life as occurred last summer be prevented. The truth of the general proposition cannot, I think, be questioned that the settlements of Montana can best be protected by troops removed from their immediate vicinity and pushed out toward the sources whence hostile incursions are to be apprehended.

Suggestions as to the use of cavalry on the Carroll road.

Suggestions as to the defense of the Montana settlements.

July 30.—The stage came in an early hour, bringing word from the commanding officer at Camp Lewis that, much as he desired to do so, he had no transportation or men that he could possibly send. Colonel Otis therefore hired such transportation as could be obtained in Carroll; and securing a few rifles and rounds of ammunition, we started soon after midday, our escort being half a dozen unarmed recruits, *en route* to Shaw.

Start from Carroll.

The road out of Carroll leads up a long sharp ridge to the west, constantly ascending, with many turns, until an altitude of over nine hundred feet above the "town" is attained; the view thence was wide and varied. Up and down the river, the valley, sinuous and green, its steep slopes scored by deep ravines, could be traced for many miles. Bordering that, the tumbled Bad Lands on the south bank and the yellow prairie on the north, and in the distance the various ranges of mountains in detached groups—the Bear's Paw, seventy miles to the north and west; the Little Rockies, thirty miles north; the Judith Mountains, forty miles south and west; with the Great and Little Moccasins close by, and the Snowies beyond.

The road at first traversed a rolling, sterile prairie, gradually descending. Camp was made on Little Crooked Creek, thirteen miles from Carroll, and in what are called the Bad Lands, which extend out from Carroll for over thirty miles. The landscape is dreary to the last degree, with rolling and broken outlines. The soil throughout the region is a finely-ground clay of dark ashen hue and texture and irregularly striped by dirty alkaline streaks. In the absence of rain, it is dry and dusty; but thoroughly wetted, it becomes a greasy, slippery, fathomless mass of clinging mud, through which the straining animals can hardly drag the heavily-weighted wheels. Wood is almost entirely wanting; water is very scarce, and when found is alkaline and tepid. The vegetation is sage and cactus, with occasionally a little thin, poor grass. Near camp two trains were encountered going in to Carroll; they halted for the night two or three miles behind us.

Maunvaises Torres.

Camp on Little Crooked Creek.

July 31.—Camp was broken early, and the journey resumed through the same enlivening scenery for twenty miles, crossing Crooked Creek, a sluggish alkaline stream, deeply cut into the dark-gray clay (where the sight of a party of mounted Indians some miles away disturbed our lunch and started us on the road), to where the bounds of the Bad Lands were reached, and the road ascended upon high rolling prairie, over which a push of seven miles led into the valley of Box Elder Creek. This is a stage-station, forty miles from Carroll, where a guard of four soldiers is maintained from Lewis. The halting-place is marked by a log cabin standing on the bank of the creek, a small stream of swift-flowing water,

Box Elder Station, forty miles from Carroll.

which has its source in the slopes of the Judith Mountains. During the day, two or three single buffalo were seen, and antelope had appeared from time to time since leaving Carroll.

August 1.—The road led in a general southwest direction along the northern foot-hills of the mountains, which were eight to ten miles distant, rising steep and wooded to the height of some 2,000 feet. The road was good, although somewhat hilly, the grass fair, and the creeks, several of which we crossed, were all bright little streams of good water. As we advanced, the mountains began to define themselves. The Little and Greater Moccasins separated from the Judith and from each other, between them appearing the distant Highwoods, with patches of snow; the Snowies, to the south, also snow-crowned; and, separating them from the Little Belt, could be seen the depression which marks the Judith Gap. The road follows the western flank of the Judith, at the southwest extremity of which, on the banks of Big Spring Creek, finally appeared the garrison-flag and the white tents of Camp Lewis, thirty-five miles from Box Elder. The camp is situated in the level valley of the creek, the garrison consisting of two companies of the Seventh Infantry, Captain Browning commanding. The creek, the main affluent of the Judith River, rises a few miles above Lewis, in a huge spring, from which the stream emerges, full-grown, with a rapid, tumultuous current of ice-cold water, abounding with the black-speckled mountain-trout. The course is northwest in a gravelly bed 15 or 20 feet wide and 1 to 2 feet deep. Wood has in a great measure to be hauled by the garrison from the mountains, but the grass is rich and luxuriant.

August 2.—Lewis is the second stage-station on the Carroll road, seventy-five miles from the "town." We lay over one day to rest the animals.

August 3.—Took the road again at an early hour, ascending upon a partly level and rolling prairie fairly grassed over, where rapid progress, parallel to the Snowy Range, was made, crossing several fine creeks which rise in the Snowies and flow north and west into the Judith River.

The Judith Basin, a sketch of which is given, opened to the north and west, showing a fine, well-grassed, gently-rolling prairie, some fifty miles east and west and sixty miles north and south, of irregular diamond-shape, and inclosing about 1,500 square miles, from the borders of which rose, massive and detached, the encircling ranges, the Judith, Snowy, Little Belt, and Highwoods. Throughout this elevated region (and more especially later in the Yellowstone Park), we had daily occasion to observe the marked depth and clearness of the coloring, owing, I presume, to the utter purity of the atmosphere; the colors of objects comparatively near by seemed to possess an unsurpassable richness and reality, and even on distant mountains, seventy-five or eighty miles away, while the colors were necessarily blended and their details lost, they exhibited a wonderful transparency and distinctness, undimmed by the haze and vagueness which usually obscure such distant objects. It is this quality of the atmosphere that furnishes the chief beauty of the Judith Basin, which can hardly be termed a mountainous country, although the various ranges grouped about it, and separated from each other by broad intervals, form the principal feature of the landscape. Painted in a clear, transparent purple upon the sky, and seeming hardly to rest upon the yellow prairie which forms so fine a contrast, they look like massive islands in the tawny ocean that rolls against them.

The basin will some day be a great stock-raising, and, by the aid of irrigation, an agricultural region. It has always been considered a fine hunting country, where game of all kinds could be found, although we saw none, with the exception of a few antelope; the recent presence of the Crow camp having driven it off.

At Ross's Fork of the Judith, near the gap, and twenty-seven miles from Lewis, we met Lieutenant Thompson, who had come out from Baker with two spring-wagons to meet us. Camp was made, with good grass and fair water; wood scarce.

August 4.—Pulled out at 6 a. m. The road led directly through the gap. From the southeast extremity of the Little Belt Mountains rises a fine spring, flowing east at first, and then doubling back through the gap into Ross's Fork.

The gap is formed by a depression five or six miles in width between the timbered Snowy and Belt Ranges. It constitutes the head of the Judith Basin; to the south appearing a broad, level stretch of prairie, sloping down to the Musselshell, twenty or twenty-five miles distant. The Crow camp at the time we passed was said to be seven or eight miles to

Camp Lewis, on
Big Spring Creek,
seventy-five miles
from Carroll.

Judith Basin.

Judith Basin.

Judith Gap

the eastward, on the southern slope of the Snowies. We also heard that a fight had taken place two nights before between the Crows and a party of Sioux, and that a war-party of one hundred Sioux had passed subsequently through the gap, going northward.

Emerging from the gap, the road led west and south over a dry, sterile, and dusty prairie, in the teeth of a blistering southwest gale, across Hoppley's Hole and Haymaker's and Daisy Dean Creeks, into the valley of the Musselshell, whose freshness and greenness and abundance of timber afforded the strongest contrast to the country behind us. The hired teams were mortally weary, and had been with the greatest difficulty urged all day against the strong, hot wind. Released from harness, they ran to the bank and leaped bodily into the stream, thrusting their muzzles deep into the cool water with great contentment. The river is twenty-five or thirty feet wide, and on the average seven or eight inches deep, of clear, rapid flow, over a gravelly bottom; the valley level, wide, fertile, and richly grassed, with heavy clumps of timber on the low banks of the stream.

Camp on Musselshell River.

August 5.—Made an early start, and at two or three miles from camp came to the "forks" of the Musselshell, where the north and south branches unite. Here a ranchman had established himself, raising cattle, and, by means of an irrigating-ditch, cultivating some seventy-five or eighty acres in oats and wheat. Throughout Montana, owing to the very thorough drainage, the general altitude above the sea, and the prevailing dryness of the atmosphere, irrigation is essential to successful agriculture.

Forks of the Musselshell.

A stage-station of the Carroll road is made at this ranch, sixty-five miles from Lewis and fifty-six miles from Baker.

The road followed west and north up the North Fork, passing through a rocky, wooded cañon of considerable beauty. Here the road, overlooking the stream, whose windings it followed, and deeply shaded by pines, made a very agreeable drive, the more so that we were now beyond any danger from Indians. Emerging from the cañon, the road led west and south over a high, rolling, and hilly prairie. At the foot of a long down-grade lay Copperopolis, which was found to consist of a mining-shaft and a deserted shanty. The North Fork of Deep Creek was reached at 4 p. m. and camp made. The creek abounded with trout, and the wood, water, and grass were plenty and good.

North Fork of the Musselshell.

North Fork of Deep Creek.

August 6.—The road led down the valley of Deep Creek west and south to Brewer's Springs, where the luxuries of a hot bath, followed by a generous breakfast, were enjoyed. The waters well up freely, strongly impregnated with sulphur, from several springs, with temperatures varying from 105° to 115° Fahrenheit. They are taken up in wooden pipes, and introduced into the bathing-houses. The odor is at first unpleasant, but the water is soft and thoroughly delightful to the skin. The color is a milky, cloudy blue, and soft, delicate filaments of sulphur adhere to the sides of the bath and stream from the mouths of the supplying-tubes. A small hotel has been built for the accommodation of visitors. At this point unite the two forks of Deep Creek, which, bearing the name of Smith's River, flows here north and west past Camp Baker to join the Missouri. The Carroll road bifurcates, one branch going west over the mountains, the other following the rich and fertile river-valley, which supports thousands of cattle on its lush pasturage, until at sixteen and three-fourths miles from the springs the road reaches Camp Baker, where it deflects to the west, toward Helena.

Brewer's Hot Sulphur Springs.

Bifurcation of the Carroll road.

The post is an irregular-looking cluster of buildings planted in the midst of a level and stony plain, surrounded by mountains, upon which frequent patches of snow appear. An irrigating-ditch brings a current of water through the garrison, but hardly appears able to vivify the arid soil. The troops at Baker are two companies of the Seventh Infantry, Major Freeman commanding. I found here my party awaiting me, and without loss of time made preparations for the trip to Ellis. The transportation and escort which had hitherto accompanied the party had returned to Ellis, and as the road to that point was considered comparatively safe, a small force only was needed.

Camp Baker, Mont.

August 7.—Pulled out at 8 a. m., with transportation consisting of two six-mule teams and a four-mule ambulance, with saddle-horses for the party, and a sergeant and two men for guard and camp duty. There are two routes from Baker to Ellis: one, called the Duck Creek route, via the Missouri and Gallatin Valleys, is perfectly safe, being within the set-

Two routes from Baker to Fort Ellis.

tlements, but several miles longer than the other, called the "outer" route, which, returning nearly to Brewer's Springs, goes up the South Fork of Deep Creek almost direct to Ellis, passing between the Crazy and Big Belt Mountains. From the springs south, the valley is at first broad and level and heavily grassed, the creek flowing northward. Many antelope were seen grazing in the meadows. Camp was made at 3.30 p. m. near a fresh, cold spring issuing from the hill-side on the east bank of the creek. The locality is the ordinary halting-place, twenty-seven miles out of Baker, and is called Moss Agate Springs. The grazing and water are excellent, but the supply of wood is small.

August 8.—Course continued nearly south up the valley. The creek gradually became smaller and finally was dry. "Sixteen-mile Creek", a branch of the Missouri, flowing a strong current west and south, was crossed eleven miles from camp, and the road beyond lay over a dry, yellow, gently-undulating prairie, which farther on grew more hilly, and became an interminable waste of sage-brush. The antelope were numerous during the day. Cottonwood Creek, a small branch of Shield's River, was crossed thirteen and a half miles from Sixteen-mile Creek. The water is pure and plenty, and the valley well supplied with cotton-wood trees. Continuing, the sage-brush still occupied the ground, and camp was finally made on a small creek flowing east, the valley of which furnished an ample supply of excellent water and grass, and wood sufficient for camping purposes. Bridger Pass appeared seven or eight miles south of us, and Flathead Pass opened to the westward through the Big Belt Range.

August 9.—Pulled out at 6 a. m. The trail led into a broad valley, stretching eastward at the foot of the mountains, richly grassed, intersected by several small streams, and affording the finest pasturage for three or four herds of cattle which were browsing in the meadow. These had probably been driven over the mountains from the Gallatin Valley for the summer. Crossing the valley brought us to the foot-hills of Bridger Pass, which, though much lower than the neighboring mountains, still gave promise of an arduous climb for the heavy wagons. A creek flows out of the pass, up the valley of which a road of fair grade could be easily constructed. In the absence of this, the trail climbs several steep hills in succession, alternately ascending and descending, but constantly rising, though with more than double the necessary labor, until at the summit of a long, sloping hog-back, falling steeply on both sides, a preliminary divide was reached, whence descent was made, following a small branch, into the valley of Brackett's Creek. This is a tributary of Shield's River, flowing eastward and separating the group of mountains over which we had passed from the main range, the pass through which still lay before us. Crossing the creek, the second ascent was found to be more gradual and less severe than the former, although of about equal altitude. Reaching the second summit, the descent began down the left bank of Bridger Creek, flowing southward. The peaks to the west across the valley were lofty, varied in form, and from certain points of view exceedingly fine. Huge patches of snow rested in the more sheltered places on their summits, and one could begin to realize the altitude of 10,000 feet above the sea, which sufficed to maintain this wintry feature even under the clear, hot rays of the summer sun. The timber throughout the pass is pine, with various small woods in the creek bottoms. Grass is abundant, even among the timber, and the brooks are bright mountain-streams constantly fed from the snow-fields above, and abounding with trout. Elk and deer are numerous, though they are driven from the immediate vicinity of the trail by frequent travel and possibly by the flies, which in great numbers and varieties proved a serious annoyance to the cattle. Still following Bridger Creek, the road made a long bend to the south and west, around the base of Bridger Mountain, into the main valley, which turns west to join that of the Gallatin. Crossing the creek, the trail wound over a range of hills, and descended into the valley of the North Gallatin, upon the south bank of which, three or four miles farther west, Fort Ellis is situated.

The Bozeman Pass road, leading east and south to the Yellowstone, climbs the hill-side opposite to where the road reaches the river.

Fort Ellis stands near the head of the Gallatin Valley, for the defense of which it was constructed. It appears as an assemblage of log houses, irregularly placed from frequent additions, of uninviting exterior, but comfortable within. The garrison, General Sweitzer commanding, includes four companies of the Second Cavalry and one of the Seventh Infantry; but during the summer the mounted

Camp, on branch of Shields' River.

Bridger Pass.

Brackett's Creek.

Bridger Mountains.

Fort Ellis, on the East Fork of Gallatin River.

troops are required to guard the passes and make frequent scouts, sometimes of considerable extent, and hence spend but little time in garrison. At the date of my arrival, two companies were absent, one scouting, the other acting as escort to the party of the Secretary of War in the Yellowstone Park, while a third was preparing for the field, and started early next morning.

August 10.—Employed the day in preparations for the trip to the park. The greater portion of the necessary pack-animals were then in the park, and my arrival was fortunately timed, since they were on the return, and expected back in two or three days. By advancing to meet them, double that time could be saved. Accordingly, the baggage was reduced to the smallest possible amount. All trunks and boxes were left behind, and the necessary articles put into canvas sacks, brought from Saint Paul for the purpose. Tents were discarded and only tent-flies carried. The instruments were carefully rolled in bundles of bedding, and the basket containing the chronometers strapped to the spring-seat of the odometer-cart. Riding-animals were obtained and a six-mule team secured to carry the baggage and stores until the pack-train should be met. Toward evening we went into camp about three miles southeast from Ellis, on Coal or Rocky Cañon Creek, a small affluent of the Gallatin, uniting with it near the fort.

Preparations for the trip into the Yellowstone Park.

Camp on Coal Creek.

August 11.—Broke camp at 6 a. m., and proceeded across the creek and up its valley. The trail followed the creek-bottom, crossing it several times, and over a rocky, hilly road, through a cañon of considerable grandeur, shaded by lofty, precipitous limestone pinnacles. The general course was south and east, up the east bank of the creek, gradually ascending and bending more to the southward. The road improved, the available space becoming greater and the hills less steep. Crossing a low divide extending across the valley, the head of Trail Creek, a tributary of the Yellowstone, was reached. Through both creek-valleys, the flies were very numerous and annoying. There are two ranches on Trail Creek, the second one twenty-five miles from Ellis, where the creek-valley widened and entered that of the Yellowstone, which presented the familiar features of a broad, dry, stony stretch of prairie, sloping down to a beautiful stream, with borders fringed with trees. The river has a stony and gravelly bed, an impetuous current of six or seven miles an hour, a depth of as many feet, and width of about 100 yards. The waters, constantly freshened by mountain springs and torrents, are cold and clear, and alive with trout of great size and variety. These range in weight from half a pound to two pounds and upward. Their favorite food is the grasshopper, great numbers of which fall into the stream, but they will also take the fly freely.

Cañon on Coal Creek.

Trail Creek.

Yellowstone River.

The Snow Mountains border the river on the south and east, their lofty pinnacles glittering with snow. Chief among the range is Emigrant Peak, rising 6,000 feet above the valley and attaining an altitude of 11,500 feet above the sea. It is a very handsome mountain, of fine outline and great richness of coloring. Débouching from Trail Creek, the road bends south and west up the left bank of the river. We here met the party of the Secretary of War, in two spring-wagons, going in to Ellis. The pack-train had been left behind at Gardner's River Springs, to follow more leisurely. Pushing on up the valley, crossing several small brooks flowing from the mountains, and passing two or three ranches, camp was made near Bottler's ranch, half-way to the Mammoth Springs and thirty-five miles from Ellis. Sufficient wood was readily attainable, and a swift-flowing brook was close at hand; but the grass, never luxuriant, had been thinned by frequent camping.

Emigrant Peak.

Camp near Bottler's Ranch.

August 12.—Broke camp at 8 a. m. The road passed Bottler's ranch, where travelers can find fairly good food and lodging, and proceeded up the level valley to a rocky point coming down from the mountains to the river-bank. Surmounting this, we followed up the valley again, crossing two or three rude but sufficient bridges, at one of which was a toll-house. It appeared that a company in Bozeman had obtained a territorial charter for a toll road from that place to the Mammoth Springs. The road had been made practicable for wagons, and considerable work expended upon it up to the toll-bridge; but the main labor directed to the cañon above, which had hitherto been a serious obstacle and impassable to vehicles. Continuing, the road bent more to the south, and entered the cañon, following a hilly trail, blasted out of the rocks. The cañon is some three miles in length, and the view from the highest part of the road is very fine. The river, compressed to a width of 75 or 80 feet, is of a rich

Toll-road from Bozeman to Mammoth Hot or Gardner's River Springs.

Second Cañon of the Yellowstone.

green hue, splashed with white, and flows with great velocity; its surface breaking into great waves and swirls. The mountains on either side are 2,000 or 3,000 feet in height, rising precipitously from the brink, and exhibiting dark browns and grays, contrasting with the deep, somber hue of the pines and the more sparkling green of the river, flecked with foam.

Camp was made at the upper end of the cañon, on the bank. All the essentials for camping were present, and trout abounded in the swift and turbulent waters. The grayling, a long, slender fish, of less weight than the trout, but rivaling it in activity and game qualities, competed successfully for the fly with the larger fish.

August 13.—Started at 6.30 a. m., and soon afterward met Lieutenant Doane, with the pack-train. The six-mule team was exchanged for pack-mules, and, after some three hours' delay, the journey was resumed.

Cinnabar Mountain stands in the valley, on the right of the trail, and, as seen from any point of view, is a handsome peak. Looking from above it, on the river-bank, it stands out from the other elevations and makes a very striking picture. The strata are nearly vertical, with a perceptible overhang to the eastward, and strike nearly north and south. On the south front of the mountain is an immense "Devil's Slide", with smooth, dark, nearly vertical walls, some 150 or 200 feet in height (the intervening material having been removed), which curve to the right in ascending and reach the summit. Adjoining this are broad bands of red and yellow, which follow the same curve, and seize the eye at once from their brilliancy of color and vivid contrast.

The trail led us on up the valley, past two ranches, from which supplies were obtained, to within a few miles of Gardiner's River. At this point, it leaves the valley of the Yellowstone, and, over a hilly route, passes across the angle between the two streams, until, at the farther side of a level, well-grassed piece of prairie, it reaches the valley in which the Mammoth Hot Springs are situated. The rain had descended heavily all the afternoon and continued into the night.

August 14.—The day opened wet, but cleared in a few hours. A thorough examination was made of the springs, which well repaid it.

They have been already described with great particularity and minuteness in the reports of Dr. Hayden and Captain Jones, and a few words of description from me will suffice.

This remark is not to be confined to the locality of the springs, but must be understood as applying, and in a still greater degree, to the whole park, of which I shall not even attempt a full description, but content myself with recording only a few of the more prominent and enduring impressions received in our hurried visit.

Pressed for time, with other work to do, our constant idea was one of eager haste, and we passed rapidly from place to place, thoroughly enjoying every hour, but always with some new wonder in advance, to divert our attention and to draw us on.

The park scenery, as a whole, is too grand, its scope too immense, its details too varied and minute, to admit of adequate description, save by some great writer, who, with mind and pen equally trained, could seize upon the salient points, and, with just discrimination, throw into proper relief the varied features of mingled grandeur, wonder, and beauty.

The Mammoth Hot Springs are the first point of interest in the park, the northern boundary of which was crossed yesterday some miles back. They occupy a small valley, discharging eastward into that of Gardiner's River, and which the spring-deposits have partly filled. Our camp was pleasantly situated in the valley below the springs, among trees growing out of these deposits, in which occasional pits and holes 15 to 20 feet in depth existed. Above the camp rose the extinct spring, called, from the shape of the mausoleum which it had itself constructed, the "Liberty Cap", or "Giant's Thumb", and beyond this again a succession of terraces, rising to a height of some 200 feet, dazzling white in the sun, indicated the presence of the active springs, which, indeed, had all along been evident enough from the vast clouds of vapor constantly arising. The terraces exhibited great variety and beauty of form, much enhanced by the quivering and sheeny effect of the thin, descending sheets of water.

The material is a carbonate of lime, deposited by the cooling of the waters, of a nearly pure white, and, while wet, of a moderate hardness. Upon drying, the deposit becomes soft and friable,

and a hunting-knife could be easily plunged into it to the hilt. The main springs occupy the upper portion of the terrace, and spread out into large limpid pools of a superb blue tint, boiling violently in places, and emitting clouds of steam. Overflowing the pools, the waters escape down the face of the terraces, and, in cooling, gradually part with the carbonate held in solution, making constant additions to the ornamentations of the surfaces, and constructing scalloped pools and "bath-tubs" of every form and temperature.

The whole vicinity of the springs returns a hollow echo to the tread, highly suggestive of pit-falls beneath. The party, however, overran the neighborhood, at first with tentative step, and afterward with all confidence, no accident occurring. Remains of extinct springs abound above and below the active ones, while still others in full flow exist near the river's edge.

The grass in the valley of the springs is poor, but on the small prairie above is excellent. Wood and cold water are sufficiently abundant and convenient.

There are two "ranches" near the springs, which do duty as "hotels", and are available for the use of travelers.

August 15.—Wagons can be taken as far as the springs without much difficulty; the road having been made entirely practicable, though of an occasionally undesirable steepness. At the springs, however, wheels must be abandoned, and everything carried upon pack-animals.

The odometer-cart was left behind, both on account of the difficulty of getting it along, and the danger of rendering it unfit for use on the return trip to Carroll. The mean The pack "outfit." solar chronometer was left with it, in charge of the "hotel"-keeper, and the sidereal was rolled in a bundle of bedding, and intrusted to the somewhat uncertain fortunes of the packs. All other reductions had been made at Ellis, and camp was broken at 8.15 a. m.; the "outfit" consisting, besides the party and the engineer soldiers, of three packers, a farrier, and a cook, in all twenty-two persons and thirty-three animals, of which eleven were pack-mules carrying about two hundred pounds.

The trail (a bridle-path only) leads up the valley of Gardiner's River (which is of considerable depth, and slopes steeply down to the water's edge) across the West Fork, and Gardiner's River Valley. then the East, gradually climbing the eastern side of the valley to a plateau, whence on the right of the trail descend the waters of the river, and form a very pretty fall. The slopes of the river-valley are composed of loose basaltic *débris*, making a toilsome path, deeply gashed in places by washings from the foot of the great basaltic wall which towers above it on the east. Although not insecure, the ascent to the plateau is unnecessarily difficult, and a little labor expended upon it would serve to improve it greatly.

The falls are some 20 feet in width, and make three plunges, estimated at about Gardiner's River Falls. 45, 55, and 30 feet each; in all a descent of 130 feet.

Leaving the river, the trail follows up in an easterly direction the shallow valley of a small brook called Black Tail Deer Creek, which traverses an open hilly prairie, and affords an excellent and easily-traveled road. Reaching the head of the creek, the Divide between Gardiner's and Yellowstone Rivers. trail bore to the right, through a dry cañony place to the edge of the valley of Meadow Brook, where, turning sharply to the left, it descends along a steep high slope, out of which the narrow trail is cut, to a fine open meadow, well grassed and watered, where camp was made, thirteen miles from the springs. Several of the party rode on a mile and a half Yellowstone River near the falls farther to the Yellowstone River. It was found to be a foaming torrent, some 60 feet in width, with steep rocky banks. The water, a rich green in hue, was broken into pools and eddies by obstructing bowlders, and a strong odor of sulphur pervaded the air. The bridge over the Yellowstone. Spanning the stream is a rough bridge some 80 feet in length, resting upon cribs at either extremity, and affording a passage to the east bank, where, at a short distance from the "bridge", is the "ranch" of Jack Baronet.

Two or three miles below the "bridge", the two forks of the Yellowstone unite, and, to the traveler approaching it, the locality is marked by a large flat-topped butte, with steep escarpments, which stands in the angle, and from its shape is a noticeable object, contrasting with the pointed hills and peaks which surround it. The West Fork drains the lake, and the East, a mountainous district not yet thoroughly examined.

Rain fell again during the afternoon and night, and our experience of the weather in the park seemed to be similar to that of Captain Jones, as recorded in his report. On one day only of the two weeks passed in the park did we fail to have rain or shower, and night observations were in consequence greatly interfered with.

August 16.—Camp was broken at 8.30. The herd had wandered during the night, and a couple of hours were lost in getting them in and ready for the road. The pack-mules had been employed on similar duty just before, and heavily laden. The construction or adjustment of the army pack-saddle is doubtless capable of great improvement; at any rate, the backs and shoulders of the animals were in very bad condition, and one of them was found to be so unfit for a load that it was necessary to leave him at the bridge.

While in the park, as there was no grain for the animals, they were allowed free range at night, and the grazing is so plentiful and nutritious that the majority of them held their own, although the work was occasionally severe. There need be little or no apprehension from Indians, and guards were not posted after leaving the Mammoth Springs.

The trail from Meadow Brook leads up the left bank of the Yellowstone, winding among some low hills, and at four and a half miles from camp makes a precipitous plunge into the valley of Tower Creek, crossing which it ascends the opposite bank by a more gradual incline. The stream is a strong rapid brook, 12 or 15 feet in width, and a foot or two in depth, with a stony bed, the waters fed from the snow-fields of the mountains. A short distance below the crossing are the falls, which leap down 150 feet into a narrow, dark cañon some 480 feet in depth. Basaltic-tufa cones and columns in the vicinity of the fall have suggested the name, and all the surroundings are picturesque in the highest degree. The finest view of the falls can be gained from a projecting spur on the south bank just below them, whence both the cañon and the creek-valley above can be seen. The stream discharges into the Yellowstone River near by, and at its mouth very fine fishing rewards the visitor.

There seem to be two varieties of trout here, the bulky ones of the Yellowstone, with bright-yellow bellies and stripings of red, and a smaller kind more silvery in appearance, and exhibiting much greater activity and game qualities. These latter seemed to come generally from the creek. The mouth of the creek may be called the lower end of the Grand Cañon, which extends up the river some sixteen miles to the foot of the Great Falls.

Leaving the creek, the trail, alternately rising and falling, and curving to the right and left, gains the foot of a long, somewhat rolling ascent, which finally attains the western shoulder of Mount Washburne. The flanks of this incline fall steeply on both sides, displaying to the west an ocean of deep-green pine, surrounded by ragged, bare pinnacles, and to the east breaking into the foot-hills of Washburne. This incline is approximately located on Reynolds's map, and called the Elephant's Back, which name has on some later maps been transferred to a minor elevation near the Yellowstone Lake. The name is appropriate and descriptive, and, having been given by the first topographer of the region, should be allowed to have its original application.

Over this the trail by a gradual ascent reaches a high point on Mount Washburne, passing between banks of snow, which had remained unmelted by the summer's sun. Here, leaving the trail, the party ascended to the summit of the mountain. The climb was made in less than an hour, and can almost be accomplished on horseback, so rounded is the mountain-top, although consideration for the saddle-horses would suggest making it on foot. In passing some stunted pines near the trail, it was observed that there were no branches or twigs on the northwest side of the tree, and that those which sprung from the northeast and southwest sides were twisted back and trailed away to the southeast. The explanation of this was not long in doubt. Reaching the summit, the whole panorama of the park sprung into view: the lake, with deeply sinuous shores and silver surface, interspersed with islands, with the Yellowstone River crooking away from it toward us, was set, as it were, in a vast expanse of green, rising and falling in huge billows, above which here and there jets of steam arose like spray; the encircling peaks, ragged and snow-clad, almost too numerous to count; Mount Humphreys, thirty or forty miles southeast, Sheridan and Hancock the same distance to the south, and beyond and above them,

ninety miles away, looking almost mysterious from their distance and vast height, the Tetons, of a pale purple hue, with their piercing summits glittering like icebergs. Only to the southeast, looking toward the great Idaho Desert, did a space appear which showed no prominent peaks. We had scarcely time to more than glance at this superb landscape, while resting and eating lunch with the aid of a hatful of snow from a neighboring bank, when a ferocious squall of hail, rain, and snow burst upon us from the northwest, and swept us like dust from the bald summit of the mountain. We were instantly compelled to seek shelter on the lee side, where, cowering and half-frozen, we awaited the passing of the storm. Motion, however, was absolutely essential to warmth; so, without again trusting the untender mercies of the mountain, over which the wind still blew keen and cold, we plunged into a deep ravine leading steeply down its western flank, and regained the trail at the foot. The storm had wet the rich black mold, and made the path slippery and difficult through the densest timber of spruce and pine, where hardly sufficient cutting had been done to afford the narrowest of passage-ways. The projecting branches flapped back their freight of rain-drops into our faces and clothing, and many of the broken twigs bore trophies snatched from the packs.

Mount Washburne.

There were several sharp pitches into and out of the valleys of small brooks, which could easily be avoided. At present, the trail is unnecessarily hilly and fatiguing, although delightful on account of the fine forest and the great number and variety of the flowers. The grass is everywhere luxuriant and sweet, the brooks are frequent, and flow in all directions, and camp could be made at almost any point. The trail, however, might be greatly improved by means of a little well-directed labor and the exercise of better judgment in selecting it. The work of a pack or saddle animal is vastly increased by unnecessary ascents and descents, which both their conformation and the position of the load render arduous, and the easiest road is one of even grade, though it be thrice the length of the more direct one.

Ascending to a low divide between two mountains, the valley of Cascade Creek was reached and followed to camp. The last three or four miles were over a meadow which in many places was wet and very boggy. The hail here had fallen in considerable quantity, and whitened all the ground; the sky was dark, and the air raw and wintry. Camp was made on the east bank of the creek, where it leaves the meadow and enters the narrow, steep valley through which it reaches the Yellowstone. A roaring camp-fire soon restored the warmth and cheerfulness of the party, which had been somewhat impaired by the shivering weather. We were only about a mile from the falls, and after everything had quieted down to silence their deep roar became vaguely audible. The evening was again cloudy and rainy. Distance traveled during the day estimated at eighteen miles.

Mount Washburne
to camp on Cascade
Creek.

August 17.—Lay over in camp to visit the falls. The night had been cold, and by 8 a. m. the hail of yesterday had not disappeared. Waiting an hour longer for the sun to dry the heavy grass, we took on foot the trail which led us to the brink of the river-valley, half-way between the Upper and the Lower Fall, which are half a mile apart. Reserving the Lower Fall, whose deep thunder we could now plainly hear, we descended toward the Upper, and, after a short scramble over loose trachytic blocks, climbed out upon a point which, projecting into the cañon below the fall, furnished a fine view of it almost *en face*. The river makes a sharp bend to the eastward just above the fall, which in consequence fronts nearly at right angles to the general direction. From the sharp and narrow pinnacle on which we stood, or rather to which we clung, the cataract, some 150 feet distant, was exposed in its full height and beauty. It is a slanting one, having a base of perhaps one-half its altitude, which, as measured by a cord brought for the purpose and marked in ten-foot lengths, is 110 feet. The water leaps down its rocky slope between black, shining walls of trachyte, and its pure green is broken into foam and spray from the very summit. From the foot the currents of air drove the clouds of vapor up the steep sides of the cañon, which were clothed in vegetation of the freshest and most brilliant hue, while a double rainbow illumined the surface of the stream below. The picture was certainly a beautiful one, and we hung over it in delight for an hour, which, with the thunder of the Lower Fall still fresh in recollection, was all the time we could afford. Half an hour of rough climbing over boulders and loose trachytic blocks, across Cascade Creek, and down the side of the main valley, brought us to a small plateau at the very crest of the main fall,

Yellowstone Falls.

Upper Fall, 110 feet
in height.

Upper Fall.

and almost at the water's edge, where the eye could plunge into the vast chasm below the fall, known as the Grand Cañon. I had not time to think of it then, but was afterward not a little amused to remember that we passed on the way one of the men who, seated on the bank, was pensively watching for a trout to seize his grasshopper. He had evidently wearied of too much bacon and scenery, and proposed a change at least of diet.

The view of the Grand Cañon from the point where we stood is perhaps the finest piece of scenery in the world. I can conceive of no combination of pictorial splendors which could unite more potently the two requisites of majesty and beauty.

Close at hand, the river narrowed in its bed to a width of some 70 feet and with a depth of 4 or 5 feet, through the pure deep green of which the hardly wavering outlines of the brown boulders beneath are distinctly visible, springs to the crest with an intensity of motion that makes its clear depths fairly seem to quiver. Just before making the plunge, the stream is again contracted, and the waters are thrown in from both sides toward the center, so that two bold rounded prominences or buttresses, as it were, are formed where green and white commingle. Lying prostrate, and looking down into the depth, with the cold breath of the cañon fanning the face, one can see that these ribs continue downward, the whole mass of the fall gradually breaking into spray against the air, until lost in the vast cloud of vapor that hides its lowest third, and out of which comes up a mighty roar that shakes the hills and communicates a strange vibration to the nerves. From far below this cloud emerges a narrow, green ribbon, winding and twisting, in which the river is hardly recognizable, so dwarfed is it, and creeping with so oily and sluggish a current, as though its fall had stunned it. On either hand, the walls of the cañon curve back from the plunging torrent, and rise weltering with moisture to the level of the fall, again ascending 500 or 600 feet to the pine-fringed margin of the cañon; pinnacles and towers projecting far into the space between, and seeming to overhang their bases.

These details are comparatively easy to give, but how find words which shall suggest the marvelous picture as a whole! The sun had come out after a brief shower, and, shining nearly from the meridian straight into the cañon, flooded it with light, and illuminated it with a wealth and luxuriance of color almost supernatural.

The walls appeared to glow with a cold, inward radiance of their own, and gave back tints of orange, pink, yellow, red, white, and brown, of a vividness and massiveness hopeless to describe, and which would overtax the powers of the greatest artist to portray. The lower slopes, wet with spray, were decorated with the rich hue of vegetation, while through the midst the river, of a still more brilliant green, far below pursued its tortuous course, and the eye followed it down through this ocean of color until two or three miles away a curve in the cañon hid it from view and formed its own appropriate background.

The height of the fall, as ascertained by attaching a heavy weight to the measured cord, and lowering it down, is 310 feet. The first attempt to get the height was made from the little plateau by the side of the crest, but the spray soon hid the weight from view, and the water so tore at it that it was impossible to tell when the bottom had been reached. A point was found, however, to the left and in advance of the crest and some eighty feet above it, from which the weight fell nearly vertically, and by aid of the colored tags which marked the intervals of the cord could be followed with the eye until it reached the brink of the stream below. From this same point, a sort of perch upon the very border of the precipice, can be had a most comprehensive view at once of fall and cañon.

After making the measurement, we ascended the side of the cañon, and climbed out to one of the projecting pinnacles, half a mile farther down stream, whence a full view of the fall was obtained. It was remarkable to note how small a portion of the view was actually filled by the fall itself. Tremendous as it is, it seems but a minor incident in the picture constructed on the huge scale of the cañon.

From the projecting point, the width of the chasm across the top was estimated from the range of a carefully-sighted rifle at 700 yards. This, however, is greater than the average width, the cañon just below narrowing considerably and gaining at the same time in depth, which is about 300 yards. The corresponding cross-section would be similar to that

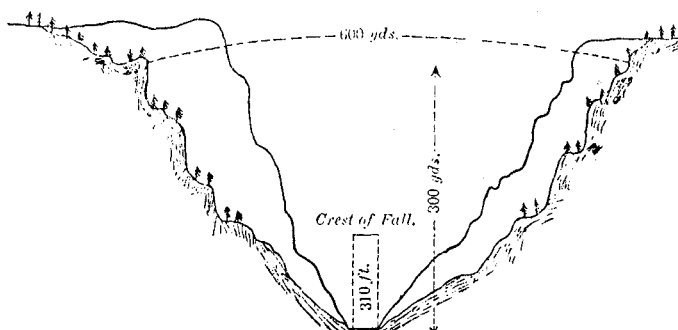
Lower Fall, height
310 feet.

Lower Fall and
Grand Cañon.

Measurement of
the Lower Fall.

Lower Fall and
Grand Cañon.

in the accompanying sketch, which is intended to show the dimensions just below the fall, and another section farther down.



Sections of cañon just below the Lower Fall and farther down. Scale, 600 feet to 1 inch.

The descent to the bottom of the cañon from the east side is comparatively easy. From the west side it has also been accomplished, but it is toilsome and not unattended with danger, and the time necessary to descend and return would be considerable. Among other improvements that suggest themselves to the visitor as proper to be made in the future is the construction of facilities for making this descent, such as rude but strong ladders, which could readily be placed in position where their aid would obviate all danger and decrease the fatigue. One of the party made an attempt to get down, but lost time in looking for the most favorable place, and the afternoon waning, he was compelled to abandon the undertaking.

Descent to the bottom of the cañon difficult.

August 18.—The morning opened cold and foggy. Camp was broken at 8. Took the trail which crosses Cascade Creek near the river by a steep pitch, and after a short ride over hilly ground and through timber reached comparatively open ground on the bank of the river, which was there 100 to 200 yards wide, and peaceful enough, flowing with smooth, gentle current, between low, grassy banks. The pack-train meanwhile had taken a trail somewhat farther to the westward, which avoided the steep descent into Cascade Creek and made an easier crossing of it. The two trails united at a small creek discharging into the river, crossed it, and through dense timber climbed around the shoulder of a mountain to again descend into the broad open valley of Alum Creek. This is a shallow, sluggish stream of tepid, undrinkable water, some 30 feet in width and an inch or two deep, with a general north-east course to the Yellowstone. Off to the right, across an open prairie, appeared the Sulphur Springs, or Soda Mountain, as it has been called, which we visited. Some forty or fifty acres are covered with extinct and active springs and their deposits. Pure sulphur in considerable quantity is distributed over the surface. Several springs were boiling violently, one of them to a height of 3 or 4 feet, and emitting large volumes of steam. Pursuing the course again toward the river, over a hilly prairie, and crossing one or two creeks and arms of the river, and a broad meadow, the borders of which were springy and boggy; the trail led to the edge of some timber, soon after entering which the Mud Geysers were found. We passed on to a small pine grove, favorably situated for camp near the river and twelve miles distant from Cascade Creek. Leaving the horses, we returned on foot to examine the geysers. The main one is a bubbling pool of muddy, hot water, some 50 or 60 feet across, with a sloping shore 4 or 5 feet high, and numerous small vents and springs within the perimeter. The water is thick with gray, unwholesome-looking mud, and exhales a fetid odor.

Break camp for the lake.

Alum Creek.

Sulphur Springs.

Mud Geysers.

Another geyser, much more impressive in appearance, which however has not been seen to spout, at least of late years, has a crater some 50 feet in diameter and 25 feet deep, narrowing at the bottom to a mud pool of the consistence of boiling mush, about 15 feet across. From the northwest side of this a perpetual boiling takes place, with a threatening roar and huge clouds of steam. If the mud apparently splashed upon the trees in the vicinity would serve as an indication, when an explosion does take place the display must be a very fine one. The "Devil's Workshop" is a small steam spring issuing from a little cavern apparently 15 or 20 feet in depth horizontally, but con-

stantly obscured by a great volume of vapor. Hollow, bubbling noises continually issue from it, which simulate, by aid of the cavern, the metrical clang and clash of great pieces of machinery, turning and splashing, accompanied by a recurring hiss of escaping steam. About 4 p. m., pistol-shots from the Mud Geyser summoned us to witness an explosion. The water had risen gradually until the smaller springs were submerged and the basin enlarged to its full dimensions. Near the center, the geyser was boiling and bubbling actively, and soon spurted to a height of 5 or 6 feet, falling and rising again, and after about three minutes of excitement subsided, the water lowered, being gradually swallowed down the several orifices, and the discharge was over. The geyser has a period of about $4\frac{1}{2}$ hours, and several of the subsequent eruptions were witnessed. None exceeded 10 or 15 feet in height. The force is evidently weakening, as indeed the large number of dead and dying thermal springs seen in other localities additionally testify. This geyser has been known in previous years to spout 50 and 75 feet. There is still, however, a wonderful amount of force at work, and in a marvelous variety of forms.

The fish taken from the river near camp were in appearance large and fine, weighing two pounds and upward; but out of the large number caught, all, with one exception, were Wormy trout. affected by the worm mentioned by previous visitors and described by Professor Leidy. The appearance and health of the trout do not seem to be noticeably injured by them, but the presence of the worm in the flesh can almost invariably be detected from a slight protuberance or rounding-out on the sides. Laying this open, the worm is found, white, the size of a knitting-needle, and twisted in the flesh. We made no experiments to determine the flavor of these fish, although many of the men ate them heartily and pronounced them perfectly good. It is certainly most unfortunate that these fine fish should be so spoiled for the table. They abound in the lake and river, and, affording the finest sport, would be an immense attraction could they be used for food.

August 19.—Without moving camp, we rode seven or eight miles to a "ranch" in a grove on the west shore of the lake. From the Mud Geyser, the trail led through alternate forest and river side, with an occasional marsh, the landscape generally quiet and pastoral. Ascending upon a high prairie point, the lake lay before us, a beautiful sheet of water, with deeply-indented shores, and the wooded mountains closing it in on all sides. We chartered a small center-board cat-rigged sail-boat, cleverly constructed by the owner of pine cut out of the forest with a whip-saw, and crossed to the east shore. The water appeared filled with a round greenish seed, probably of some aquatic plant, and little windrows of the same seed lay upon the beach, thrown up by the waves. Some trout were taken with a spoon on the way over, all wormy, and a squall or two gave variety to the sail and tested the weatherly qualities of the boat.

We passed the mouth of Pelican Creek, in the valley of which large numbers of thermal springs have been found, and landed near Steamboat Point, seven miles from the starting-point. Two or three steam-vents were seen, and one of them on the farther side of the point has suggested the name. From a small aperture, colorless superheated steam escapes with a hiss and roar that indicate an excessive tension, and imitating precisely the blowing-off from a full boiler. Multitudes of grasshoppers, unwittingly encountering the steam, had met instant death.

From the projecting point, some 12 feet above the water, the finest fly-fishing was found. An arc of nearly 180° could be covered with the fly in from 6 to 10 feet of water, out into the lake as far as the skill of the fisherman would admit. The fish, though sometimes gorged with grasshoppers, would rise eagerly to the fly, and weighed from $1\frac{1}{2}$ to 4 pounds and upward. The largest measured 20 inches in length. None of them could be eaten.

August 20.—The trail to the Great Geyser Basin breaks away from the vicinity of the Mud Geyser to the west and north over an open sage-brush prairie, gradually becoming more hilly, crosses Alum Creek near its head, and following up a small *coulé* with flowing water at six miles from camp, climbs a hill and enters a heavy forest richly grassed. The ascent through this forest to the summit of the divide between the Yellowstone and Madison Basins is very gentle from the east. Two or three groups of sulphur springs were passed on the way. The descent from the divide into Madison Valley is precipitous, winding down a drop of a thousand feet through fallen and burned timber, and over a rocky, bare, and stony soil destitute

of grass. Reaching the border of the valley of the East Fork of Madison River, the trail winds along the foot hills, to avoid an alkaline, boggy meadow, finally crosses the meadow and two or three alkaline brooks, in which the animals mired badly, and follows down the bank of the East Fork, which was forded two or three times. The stream is 10 to 20 feet wide and 2 or 3 feet deep; a clear, swift current and gravelly bottom, the water tepid and alkaline from the numerous hot springs which discharge into it. Camp was made in a grove of pine, after having traversed a pass between two hills which project into the Lower Geyser Basin. A small rill furnished a sufficient supply of good water, but the grazing was inferior. Several hot springs had been passed before reaching camp, and to the south the geysers appeared covering a large area. The distance traveled during the day was about twenty-six miles.

East Fork of Madison River.

Camp in Lower Geyser Basin.

The upper valley of the Madison, including those of the forks, is quite barren and unattractive, owing probably to the action of the chemical hot springs which abound everywhere. The bordering hills are stony and bare, and at the time of our visit were covered with dead and burned timber. The landscape in consequence is uninviting, the grass poor, and good camping-places, such as can be made at almost any point in the Yellowstone Basin, are not to be found.

August 21.—The morning was devoted to the examination of the springs and geysers of the Lower Basin, which are very numerous, and cover a large extent of ground, the principal ones being about half a mile to the southward and eastward of camp. Minute descriptions of them have been published, and a detailed account is here unnecessary. Some are boiling, others spouting springs, the latter generally intermittent. On a high mound built by the geyser, we found a large pool about 25 by 15 feet, which was known to play, and the discharge of which we awaited. The water, of a deep azure hue and a surpassing clearness, was rising gradually but constantly to the level of its scalloped and ornamented rim, constantly becoming hotter, with bubbles of steam escaping more and more rapidly. Ebullition began near the middle, and the geyser finally commenced to spout, throwing the water about in all directions and to heights varying from 10 to 50 feet. The display continued for over an hour, and we left it playing, but with gradually-diminishing force. Meanwhile other smaller geysers in the vicinity played from time to time, all apparently independent of each other. The pools of all these, exhibiting every variety of form and ornamentation, possessed in common the beautiful azure tint and clearness of the water, contrasting finely with the light-gray hue of the silica deposited by them. The margins of all were incrustated with this in various forms of bead, coral, and sponge work, and wherever the geyser water flowed silicious shale was deposited.

Lower Geyser Basin.

Passing over a low ridge, a few hundred yards to the southeast, we came upon the "Paint Pots". This singular phenomenon consists of a "pool" some 60 by 40 feet, with a raised margin of dry and cracked mud, within which numerous mud puffs slowly rose and fell, some through the partially liquid mass, which again closed over them, others possessing a small crater of their own, to which additions were constantly making from the bursting of the sluggish bubbles. The pool displayed various colors, white, yellow, and red predominating, but shading into each other very beautifully through all the intermediate and combined tints. The clay was soft and smooth to the touch, with scarcely a trace of grit, and near where the bubbles emerged from below exceedingly hot.

The Paint Pots.

Leaving these, and passing by many other springs and small geysers, we went down to the Fire Hole River, crossed it, and pushed on up the west bank toward the Upper Basin, wherein are situated the Grand Geysers. After some two or three miles of travel over fallen timber and through marsh and bog, we came upon some immense springs and pools, boiling violently and discharging a great amount of water into the river. These exhibited many hues of red, yellow, and green, from the presence of iron and vegetable growths; the pure geyser blue appearing where the spring was deepest and clearest. From the pools, we continued, passing many curious springs and small geysers, and then, crossing to the east bank, pushed rapidly on through a sort of cañon on the river, until at about seven miles from camp, in the Lower Basin, we reached the lower end of the Upper, and were at once hurried across to the west bank again to examine the "Grotto", which began to play as we arrived. This geyser does not spout to any great height, 20 or 25 feet being the limit, but it is beautiful and interesting from the shape of its crater, which, some 12 or 14 feet in height, is curved and convoluted into massive

Between the two basins.

The "Grotto" Geyser.

arches and exceedingly graceful forms. It played whenever we were by to see it, and evidently continues in operation for considerable periods, from the dimensions of the crater it has built. These craters are all constructed, by the geysers themselves, of the grayish-white silica, or geyserite, deposited by the cooling of the water; the process being very gradual and slow. The water in all is of the same pure clear blue, without a trace of any impurity. The taste, when cool, is the flat, insipid one of distilled water.

Close by the "Grotto" stands the picturesque crater of the "Giant", or "Broken Horn", a geyser of the first class. From the aperture of this, large volumes of steam were escaping, and the water was boiling violently 8 or 10 feet below the surface, occasionally rising in huge spurts and splashing over, symptoms which led us to watch it unavailingly for an hour in hope of a discharge.

Meanwhile the pack-train had been making its way along the regular trail up the east bank, and, reaching the Upper Basin, camp was established in the center of the basin on the west bank of Fire Hole River, in a small group of trees, with a fairly good marsh in front for the cattle. We found the waters of the river cool and palatable, and sufficient wood for camping purposes at hand. At short range from camp, and in full view of it, were the first-class geysers named "Old Faithful", the "Bee Hive", the "Giantess", the "Grand", and the "Castle"; while the "Giant" and "Grotto" were but a short distance farther down stream. Beside these, the "Pyramid" and "Punch Bowl", near the "Giant", could be easily seen. Almost as we reached camp, "Old Faithful", which stands at the head of the valley overlooking it, and

which has earned its name from the regularity of its discharges, gave us his first display. The time was noted and the second discharge awaited. An hour after, we walked over to the elevation which marked his crater, 400 yards from camp. In a few minutes, after some preliminary spurts and splashes, the geyser, emitting a deep roar which shook the ground, shot up a clear, straight shaft of water, which, with two or three rapid impulses, gained an altitude of over 100 feet; clouds of steam towering far above and drifting with the wind. For full five minutes, the superb column maintained its height, and then, with some unavailing efforts to check its fall, sank down, and was swallowed up in the crater. An examination of this followed. An immense quantity of water had been ejected, which, after bathing the crater and refilling the adjacent pools, flowed down the slopes and discharged by various channels into the river. The crater of "Faithful" is one of the most beautiful of all. The lips are molded and rounded into many artistic forms, beaded and pearly with opal, while closely adjoining are little terraced pools of the clearest azure-hued water, with scalloped and highly-ornamented borders. The wetted margins and floors of these pools were tinted with the most delicate shades of white, cream, brown, and gray, so soft and velvety it seemed as though a touch would soil them. The material, however, is the constant silica, of which also are composed the pretty pebbles which furnish an additional charm to the pools.

The only blemishes on this artistic handiwork had been occasioned by the rude hand of man. The ornamental work about the crater and pools had been broken and defaced in the most prominent places by visitors, and the pebbles were inscribed in pencil with the names of great numbers of the most unimportant persons. Such practices should be stopped at once. The geysers are more than worthy of preservation. It is not only that they constitute a superb spectacle in themselves: they are likewise unique, both in performance and design. Nature, abandoning for the time all thoughts of utility, seems to have been amusing herself in this far-off and long-hidden corner of the world by devoting some of her grandest and most mysterious powers to the production of forms of majesty and beauty such as man may not hope to rival.

The geysers, in the slow process of centuries probably, have built up miracles of art, of an enduring though brittle material, that can be ruined in five minutes by a vandal armed with an ax, and nearly all the craters show signs of the hopeless and unrestrained barbarity of many of their visitors. It cannot fail to fill the mind with indignation to see the utter ruthlessness of these sacrilegious invaders of nature's sanctuary. To procure a specimen of perhaps a pound weight, a hundred pounds have been shattered and destroyed, and always in those places where the most cunning art has been displayed, and the ruin produced is correspondingly great. Upon our arrival in the basin, we found several persons already encamped, and a

whisky-trader snugly ensconced beneath his 'paulin, spread in the shelter of a thick pine. The visitors prowled about with shovel and ax, chopping and hacking and prying up great pieces of the most ornamental work they could find; women and men alike joining in the barbarous pastime.

With regard to the play of the geysers, our visit was well-timed. Just at twilight, the "Bee Hive", 400 feet distant, on the opposite bank of the river, gave an exhibition of its power. The crater is a small, conical, gray mound of silica, severely simple and unpretentious in appearance, with an aperture of some 18 inches, from which steam gently escapes. Near by is a small vent, which is the herald and precursor of its greater neighbor.

The "Bee Hive".

Before the "Bee Hive" plays, this vent commences to emit steam loudly, with occasional splashes of water. Soon the geyser begins to boil and steam, the water occasionally surging over. Suddenly comes a burst of 15 or 20 feet, and then almost instantly the slender shaft rises to a height of nearly 200 feet. So great is the impetus, and so slender the column, that the water, in its swift ascent, is nearly all dissolved into fine spray, which drifts off with the clouds of steam before the wind, to fall like rain. The play lasted about three minutes, and ceased as suddenly as it had commenced.

An hour and five minutes after his previous display, "Faithful" again reared his magnificent column, and during the night, whenever the roar was heard, we looked out from our tents at the grand sight, rendered more beautiful by moonlight. The intervals were exactly 65 minutes in every case.

August 22.—We were aroused at an early hour by the report that the "Bee Hive" was again about to play. This proved a false alarm, but sufficed to draw us across the river, which was some 25 feet wide and 1½ to 2 feet in depth, and while on the opposite bank we examined the huge pool of the "Giantess", which was known not to have played for some weeks, for symptoms of agitation. We found it full to the brim with beautifully clear water, of a deep blue, boiling gently, and giving out clouds of steam. It stands upon a hill of silica, 420 feet from the "Bee Hive" and 300 yards from camp.

Pool of the Giantess.

While waiting for breakfast, attention was called to the Grand Geyser, half a mile below camp, on the east bank, which had begun to send out great volumes of steam. Hastily mounting the nearest horses, we hurried down to it. The Grand Geyser is double, the two orifices 15 or 20 feet apart. The down-stream one has a handsome crater, while the other has only an ornamental pool, several feet lower. It is from the pool, however, that the discharge takes place. Rising with rapidly-succeeding impulses, the column rushed to a height of some 80 feet, sustained itself for a few seconds, fell, rose again, and receded to its basin. In a minute or two, it again shot to the same height, again faltered, rose, and subsided. Still a third effort was made and exhausted, and the waters receded until the empty basin was exposed to view, and could be examined with impunity. Meanwhile the neighboring geyser was splashing its waters in all directions, and discharging clouds of steam, while a steam-vent close at hand kept up a most outrageous roar. Though not so lofty a play as some observed by previous visitors, the exhibition was very fine; the swiftly successive pulses of water and steam breaking into beads and spray at intervals up the full height of the column, accompanied by vast clouds of vapor, and the mighty roar combined to make an imposing and beautiful spectacle.

"The Grand."

The surroundings of the "Grand" are the most ornate of all, and exhibit greater variety and beauty than any other.

The "Turban", which stands at the northern edge of the "pool", serves to distinguish the geyser. It is of singular form, highly ornamented, and I experienced almost a pang in becoming conscious of an apprehension that I should meet it again somewhere on exhibition. Some visitor, a little more enterprising than his predecessors, will be sure to detach it and carry it off. Shovel and ax had been busy with the geyser, and large quantities had been removed.

"Turk's Head", or "Turban".

While returning to camp, the "Castle", on the west bank, was observed to be in agitation and giving out vast quantities of steam. A discharge soon took place, to a height of 10 or 15 feet only; but from the commanding position of the geyser and its handsome appearance, possessing, as it does, a high mound, richly decorated, and several apertures through which it plays at once, the sight is very fine. Several times during the morning it repeated its per-

The "Castle".

formance, rarely exceeding, however, 20 or 25 feet. After breakfast we returned to the "Giantess", which was evidently becoming more excited, and, while awaiting its discharge, examined the surroundings more closely.

The basin is some 25 by 16 feet and 25 or 30 feet in depth, with scalloped margin; 70 feet north of this stands a handsome boiling spring, which has built itself a sarcophagus $2\frac{1}{2}$ or 3 feet in height, like a huge bath-tub, with richly ornamental borders. This operates in sympathy with the "Giantess"; is excited, and boils violently with her; and we afterward found it empty and desolate, upon the dissipation of her power.

About 11 o'clock, this, the greatest geyser, gave its first spout, and we continued watching its

The "Giantess". subsequent action until nearly 3 p. m. The water was expelled by a succession of

violent splashes to a height of 15 to 50 feet, but without at first reaching a great altitude. With occasional lulls, the performance went on, the water sometimes being thrown 100 feet in the air. Large stones and stumps were cast into the basin and hurled instantly to a height of 200 feet, the high wind which prevailed at the time preventing the water and steam from attaining a similar elevation. The water fell occasionally, leaving the basin empty; and by standing on the windward side we could look down into it and see the large triangular-shaped vent at the bottom, whence issued the transparent steam. Again and again the geyser renewed its strength, sending out vast volumes of steam with a deafening roar that shook the whole valley, and occasionally snatching hold of a new reservoir of water and instantly ejecting it; each fresh access of wrath or travail being heralded by deep, mighty thuds, as though some vast machinery were at work beneath. The exhibition of enormous power wasted in these prolonged spasms of blind rage was both fascinating and terrible, and the imagination, powerfully stimulated in the presence of such strength and fury, could not avoid imputing to the scene the attributes of gigantic passion and suffering. It seemed as though the geyser, maddened by some inexpressible and mysterious torment, were imprisoned beneath and gradually exhausting herself in unavailing struggles to escape it by bursting the bonds that held her, the paroxysms of efforts being alternated with intervals of stupor, again and again overcome by her still unabated rage.

During the afternoon, the "Bee Hive" again played, the high wind depressing its column below that of the previous discharge.

A party, about dark, came in from Virginia City. Following up the valley of the Madison

Virginia City to the geysers. River, they had brought two wagons without much difficulty through the Lower Basin, but were compelled to leave them a short distance above on account of the fallen timber and bog along the trail. The distance to the Upper Basin from Virginia City is one hundred and ten miles.

August 23.—All the first-class geysers had now been favorably seen, with the sole exception of

The "Giant", or the "Broken Horn". the "Giant", toward whose picturesque crater we went, with the intention of devoting the day to it. The "Broken Horn" is a well-chosen and descriptive name, and worthy of being retained. The crater is a steeply conical mound of geyserite, 12 or 15 feet in height, tapering toward the summit, and having the west side broken down, or rather partly unconstructed. The geyser still boiled strongly, and we felt great hopes of seeing it play. Near by are the "Grotto", seen yesterday, and which played almost constantly during the day; the "Pyramid", a cone of silica 25 or 30 feet high, with steam slowly escaping from it, but its life now nearly extinct; the "Punch Bowl", and smaller ones. The last-named geyser played frequently during the day, some of its exhibitions being very fine. We waited the greater part of the day for the "Giant" to give us a display, but though evidently powerfully excited and from time to time arousing fresh hopes, to our great regret it failed to do so. Returning toward camp, the "Grand" again gave indications of strong disturbance, and we remained there for an hour, but without result.

While waiting, we had additional evidence of the brutality of the average visitors, several of

More vandalism. whom, of both sexes, were busily chopping and prying out the most characteristic and conspicuous ornamental work. An earnest remonstrance was followed by a sulky suspension of hostilities, which were, however, no doubt renewed as soon as we were out of sight.

The "Saw Mill", above the "Grand", is an interesting geyser. Its lively play, and its quick,

energetic spouts of 25 or 30 feet in every direction, are very pleasing, and its borders abound in the pretty geyserite pebbles, some smooth, others ornamented, and others again resembling a rose-bud, with closely-folded leaves.

The "Saw Mill".

Recrossing to the west side of the river, a close examination was made of the "Castle:" it has quite a lofty mound, broad, handsomely terraced, and profusely decorated with scalloped pools and little upright pinnacles and towers. It plays with great frequency, though not to a height exceeding perhaps 40 feet; still its very frequent flow and almost constant escape of large quantities of steam, with its striking-looking and highly-ornamented crater, constitute it properly a geyser of the first class. This, too, showed, and even in a greater degree than others, how greatly protection against vandalism is needed. From every part of the "Castle" pieces had been chopped, loosening quantities of the rock and threatening to ruin the construction. Two women, with tucked-up skirts and rubber shoes, armed, one with an ax, the other with a spade, were climbing about. Should this continue for another year or two, the beauty of form and outline of the geyser-craters would be destroyed. It should be remembered that these craters were constructed with the greatest slowness by almost imperceptible additions, which can only be made by a discharge from the geyser; while the material, though hard, is very brittle and easily knocked to pieces. We got back to camp just in time to prevent the fall of an uplifted ax, which a woman was evidently about to bring straight down on the summit of the "Bee Hive", whose modest crater forms so strong a contrast to the grandeur of its play. Our shouts fortunately reached her just in time, and subsequent remonstrance induced her at any rate to postpone the attack.

The "Castle".

Geyser craters.

Another party of four men came over in the afternoon from the lake. Including my party, there were now some thirty visitors in the basin.

August 24.—Broke camp for the return to Ellis. I should have liked to return by way of the Madison Valley for the purpose of examining that route, which at present is the only practicable one for wagons into the park; but I had reason to believe that the Missouri River navigation would probably close about September 20, and the long journey of three hundred and seventy-five miles back to Carroll had yet to be made, and a few days' delay at Ellis, in order to refit and procure fresh transportation, to be allowed for. We took the back trail to the Lower Basin, examining *en route* the Fan, Riverside, and Sentinel Geysers. The day was cold, dark, and wet, the air chill and raw. Below the Upper Basin we met three men going to the geysers, each of whom, I supposed, would carry off 20 pounds of specimens and destroy 500. The trail between the two basins is about the worst in the park, and stands in urgent need of improvement, which could readily be effected, and without the use of skilled labor. Timber, fallen and standing, could easily be chopped and thrown aside, and the marshy places in great part avoided by making the trail on higher ground along the foot-hills. Crossing the Lower Basin, which the rain had made miry, and passing our former camp, we continued up the valley of the East Fork, the principal features of which are alkaline marsh, dead timber, and little or no grass, the surrounding hills being equally uninteresting to the rapid traveler.

The return to Ellis.

Trail from Upper to Lower Basin.

I was desirous, on the score of time, to take the trail direct from the East Fork to Gardiner's River Springs, but a brief examination convinced me that nothing would be gained, as it was obstructed with fallen timber. The ascent out of the Madison Valley to the divide was laboriously made, the rise being fully 1,000 feet, and the back trail down the Yellowstone slope pursued. The Sulphur Springs, three in number, were briefly examined *en route*. They exhibit considerable activity, though evidently waning in force. The jets of vapor deposit small cones of nearly pure sulphur.

Trail back to the lake.

Emerging from the timber, and soon after reaching the head of Alum Creek, we left the trail going on to the Mud Geyser, and inclining to the left crossed a range of prairie-hills, and followed down the left bank of Alum Creek until the main trail down the Yellowstone was reached. This was pursued for two or three miles farther, and camp made in a drenching rain on a small creek, which we named "Jay Creek," and near the point where the two trails from Cascade Creek had united coming up. We had traveled for eleven hours and made about thirty-six miles.

August 25.—Took the back trail over which the pack-train had traveled on the journey out, past our former camp of the 16th and 17th on Cascade Creek, and up the creek-valley. The day was very wet and cold, and desirous as I was of again looking at the Grand Cañon, I was unwilling to impair my vivid recollection of it by seeing it for the last time deprived of its marvelous wealth and brilliancy of color.

As we neared the belt of hills stretching nearly east and west across the trail, and commenced to ascend the shoulder of one of them, we were greeted with a sharp burst of hail, followed by successive gusty showers. The rain made the mountain-trail a hard one, turning the rich, black mold in the narrow bridle-path to a slippery mud, and making the up and down grades equally severe on the animals. The trail gradually ascends from the head of Cascade Creek to the divide between two mountains, thence following partly the valley of another creek, which rises nearly at the summit of the divide, descends a long winding slope, with many fatiguing and unnecessary rises and falls, until the west part of Mount Washburne is reached. Ascending this rapidly but laboriously to the shoulder, we were in a few minutes enveloped in a blinding snow-storm from the west and north, which forbade another ascent to the summit of the mountain, and continued until we were about to descend from the Elephant's Back. The thermometer fell below freezing, the wind blowing in furious gusts, and the snow occasionally turning to hail, with frequent splashes of rain. As we were about leaving the Elephant's Back, half-frozen and entirely discontented with the weather, a change took place. A rift suddenly opened in the clouds to the northward, and rapidly widening disclosed the mountain-tops brilliantly white with fresh-fallen snow, which reflected the clear rays of the sun; the dense strata of clouds drifting black and heavy beneath: the sun soon after reached us with grateful warmth.

The trail winds rapidly down to Tower Creek, just before reaching which two deer were seen, the only game animals we encountered in the park. A number of trout were taken at the mouth of the creek, and we were much disappointed to find that out of twenty-five cooked for supper two certainly were affected by the worm previously mentioned. It has been hitherto stated, and generally believed, that the wormy trout were confined to the lake and river above the falls. It afterward appeared that one captured in Cottonwood Creek between Ellis and Baker, and several from Deep Creek east of Baker, were affected in the same way. Camp was made at the former place on Meadow Brook, and rain came on again in the evening.

August 26.—A visit was paid to Baronet's Ranch, across the bridge, in the forks. We found there a large collection of specimens from Amethyst Mountain, on the east side of the river, a locality which we had not time to visit. The specimens were mainly impure amethysts and forms of quartz chalcedony, &c.

The weather continued unpropitious as ever, and in a drenching rain the back trail up Meadow Brook was resumed. In such weather, the trail is difficult and in places not a little dangerous. It leads along and ascends slopes of clay which the rain makes exceedingly treacherous and slippery, where a misstep would precipitate a mule with its pack or a horse with its rider down several hundred feet. A great improvement could be made with comparatively little labor by widening the trail and placing rocks on its outer edge. Rain fell all day, with occasional intervals of sunshine; the trail over the broad rolling divide between the Yellowstone and Gardiner's River affording a good road, however, even in such weather. The Gardiner's River Falls were passed, and the long, sloping descent made into the valley, out of which we again climbed to the springs, just before reaching which camp was made. The rain lasted all night with great severity; the temperature steadily falling nearly to the freezing-point. Soon after our arrival, an ambulance from Ellis reached the springs, bringing Major Benham and his wife, who were about to make a tour of the park.

August 27.—Leaving Lieutenant Thompson in charge of the party, I took the ambulance, and accompanied by Mr. Wood set out for Ellis, desiring to precede the party and gain time by having transportation ready to take us on to Carroll. The mountains and hills were covered with heavy snow but two or three hundred feet above us. The roads were exceedingly muddy and slippery; fresh rain falling at intervals during the day. At the toll-house, a certified memorandum of the Government transportation taken over the road was given to the proprietors. The tolls charged each way were \$5.50 for a six-mule team, \$4 for a four-mule team, and \$1 for a single animal.

Bottler's Ranch was reached at 5 p. m., and very good meals and lodging obtained. We observed a small herd of cattle near by, with which three young buffalo were apparently entirely domesticated. Bottler's Ranch.

I was informed that the gold washings at Emigrant Gulch, adjoining the peak of the same name, were this year paying well; the owners taking out \$10 to \$25 per man, and the net profit on each laborer being \$5 to \$15 per day. Washings at Emigrant Gulch.

August 28.—Started at 7 a. m. The heavy rains had cleared up in a hard white frost. The Bottlers have about 90 acres under cultivation, irrigating from the mountains.

Under the bright sky, Emigrant Peak looked exceedingly handsome: the upper 2,000 feet covered with a broad mantle of new-fallen snow, and the air washed clean of all impurities, brought out with exceeding clearness the noble outlines and rich coloring. The road out of the Yellowstone Valley up Trail Creek needs additional work upon it, side-cutting and bridging. That down Coal and Rocky Cañon Creek is capable still of great improvement. Ellis was reached at 2.30 p. m. Arrive at Ellis.

August 29.—Rain fell all day. The Gallatin valley was a sea of mud.

August 30.—Rain continued throughout the day. At 2 p. m., Lieutenant Thompson, with the party and pack-train, arrived.

August 31.—Weather showed no signs of improving. The necessary transportation could not be procured at the post, and it became necessary to hire a citizen's team in Bozeman.

September 1.—Still raining. This prolonged continuance of wet was pronounced to be unparalleled in the valley. Heavy rain.

September 2.—Still raining. Despairing of any cessation of bad weather, I determined to make a start and try to get over the ground if only a few miles a day. Accordingly pulled out of Ellis in the afternoon with a train consisting of a four-mule ambulance, a six-mule team, and a citizen's team, consisting of six mules and a wheel-team of two broncos or Montana ponies, the eight hauling a wagon and a trail-wagon. This is the ordinary freight-wagon of the Territory. The trail is attached to the lead-wagon by a broad, short tongue, at the extremity of which an iron eye fits upon the pintle or trail-book, projecting from the rear of the rear axle. Both wagons are provided with powerful brakes, which are set in descending hills. The two wagons can together carry over fair roads from 6,000 to 8,000 pounds. The escort consisted of two sergeants and eight men of the cavalry. Transportation out of Ellis.

By 9 p. m., the train, with the greatest difficulty, had made about six miles only, and camp was pitched in Bridger Creek Valley. The trail-wagon had to be left for the night some two or three miles back. Unfortunately, this wagon contained the greater part of our bedding and personal belongings, and, as the temperature was very low, water freezing in the buckets, the night was anything but a comfortable one.

September 3.—Sent back and brought up the trail, after which, with almost infinite labor, we made four miles and camped. Much of the difficulty of hauling over this Bridger Pass could be obviated by cutting and rough-bridging, with the labor of troops. Bridger Pass.

Three of the party came into camp late. They had been hunting in the pass; had seen a number of elk on Bridger Mountain, and killed two or three.

September 4.—Broke camp at 7, with the sun shining, and pulled up the long hill, the descent from which reaches Brackett's Creek. This hill is a plain illustration of the slight trouble required to avoid excessive labor. A road *around* this hill, nearly on a level grade, might easily be made. In fact, the road is there, except that in one place, for a hundred yards, the slope is so steep as to imperil the equilibrium of a heavily-loaded wagon. A half-day's work with fifty men would make it entirely practicable. From Brackett's Creek there is a road leading down it for a short distance; then north, up the valley of Shield's River, past the Three Peaks, to the headwater of the South Fork of Musselshell. It was represented, however, that this road was marshy in places, and, with the immense amount of rain which had fallen, would probably be impassable. I concluded, therefore, to take, in preference, the more hilly route over which we had come from Baker. About dark, after ten miles of very laborious pulling, camp was made on the north side of the mountains, at the intersection of two small streams flowing out of the pass.

September 5.—Pulled out at 6.30, and, after great difficulty, and with continual doubling of

teams and dropping the trail-wagon, which had again to be brought up, we got clear of the foot-hills at the entrance of the pass. Crossing the creek, which flows from the westward out of Flat-head Pass, and its broad meadow-valley, we continued past the camp of August 8, and over the rolling sage-brush prairie to Cottonwood Creek, where we camped, having made sixteen miles. During the day, three of the party ascended the mountains on the west of Bridger Pass, and obtained a superb view over the Gallatin Valley beyond.

September 6.—Broke camp at 7. Fair progress was made, but the effect of the wet weather was still evident in the lower places, and wherever a small creek crossed the road. Camp on South Fork of Deep Creek. Fourteen miles from Cottonwood Creek we passed Sixteen Mile Creek, and inclining eastward, and leaving the Baker road, made camp three miles farther on, at the head of the south fork of Deep Creek. There was but little wood in camp; the grass and water, however, being good.

September 7.—Taking Reynolds, the guide, I started on in advance of the train for the forks of the Musselshell, with the double object in view of intercepting the Carroll mail-stage at that point, with probable advices for me, and of obtaining, if possible, some additional, or at least fresh, transportation, the animals having been greatly pulled down by the severity of the work since leaving Ellis.

Leaving the head of Deep Creek, the trail crosses a divide 200 or 300 feet high, and strikes the head of the South Fork of the Musselshell, which it follows to the junction with the North Fork.

The route for five or six miles is rough and broken, but finally follows the creek, which flows gently in a wide, fairly-grassed valley, surrounded by mountains. Many hundreds of cattle were grazing in this valley, which is an excellent stock-range. The "Forks" were reached at noon, thirty miles from camp. Captain Ball's company of the Second Cavalry and Rawn's of the Seventh Infantry were in camp on the broad, level Forks of Musselshell. tongue of land in the angle of the two streams. This camp is just on the border of the Indian range; is well supplied with all the principal requisites of wood, water, and forage; and would be an admirable location for a permanent post for the protection of the Carroll road and the thriving settlements to the westward. These districts are threatened almost every summer with forays by the Indians, from which garrisons far in their rear could scarcely avail to guard them. These hostile invasions are always sudden and generally unforeseen, and only the promptest movements of troops can be of effect. It is not difficult to see that such movements would be greatly expedited and their effect by so much increased by meeting the Indians at the very door, as it were, and punishing them there, rather than by trusting to the uncertain chance of overtaking them after the depredations had been committed. The garrison and post of Camp Baker, for example, moved forward and established anew at the forks of the Musselshell, would make almost secure the whole country behind, and, in addition, would afford a most favorable point from which to send out scouts and reconnaissances, or, on occasion, to initiate a campaign into the Indian country. Another consideration would be that the farther east such a post was established the cheaper and easier it would be to supply.

September 8.—The train came in at 9 a. m., having camped for the night five or six miles back. Camp at Hoppley's Hole. I was fortunate enough, through the kindness of Lieutenant English, Seventh Infantry, to obtain the loan for two days of an additional six-mule team, with which at noon we pulled out on the Carroll road, in company with Captain Browning and Lieutenant Woodruff, Seventh Infantry, made the twenty miles to Hoppley's Hole, and camped by a spring just north of the road. Wood was obtained from the eastern margin of this broad and deep *coulé*, in which, however, the grass was poor and thin.

September 9.—Started at 7 a. m., in advance of the train, with Captain Browning and a small party, for Camp Lewis. Near the spring, in Judith Gap, a small detachment of Camp Lewis. Eighteenth Infantry men was in camp. Scattered herds of buffalo could be seen grazing on the prairie south of Snowy Mountains. Deviating to the right of the Carroll road, we kept along the foot-hills of the mountains, crossing two or three small streams, and finding the grass of the hill-slopes rich and luxuriant. An hour's halt for rest was made on Little Trout Creek, and, resuming the journey, a heavy, recently-made Indian trail was crossed, leading northward. Lewis was reached at 5.15 p. m., after a rapid ride of forty-five miles.

September 10.—The train came in at 2 p. m., having camped on Buffalo Creek the night before.

September 11.—Pulled out at 8 a. m., and in a couple of hours met the Carroll stage at Warm Spring Creek. I was informed that the steamer Josephine would probably leave Carroll on the 18th or 19th, but was likely to make another trip, certainly if the ^{Camp on Armell's Creek.} stage of the river would admit. Camp was made on Armell's Creek, twenty-five miles from Lewis, with excellent wood, water, and grass. Opposite camp, on the other side of the creek, was a plantation of wild hops in full bearing. Mr. Grinnell was exceedingly desirous of examining for fossils the lower extremity of the Judith Basin near the Musselshell River. As there was still a margin of seven or eight days, with the chance of a later trip of the boat, I determined to divide the party, sending a portion of it, under command of Lieutenant Thompson, to the mouth of the Judith River, while I should go on to Carroll, ascertain as exactly as possible the probabilities of a later boat, and send out word at what time the party should re-assemble. Mr. Dana concluded to accompany me to Carroll; his engagements at the East not admitting of any further delay on his part. The wagons were therefore reloaded with the view of sending one six-mule team and the greater part of the cavalry escort to the Judith.

September 12.—The six-mule team was loaded with fifteen days' rations; all superfluous baggage being loaded into the others. The supposed best route to the mouth of the Judith was to incline southwest from camp for a few miles, until the divide ^{The party divided.} between Warm Spring and Armell's Creeks was reached, thence west and north to the head of Dog River, and along the divide between that and Judith River, through a certain pass in the Bad Lands, of which we had general information only, to Claggett's Ranch or Camp Cooke, at the mouth of the Judith. At 8.30 the load was completed, and the two parties separated; Mr. Dana and myself, with a sergeant and one man of the cavalry escort and a sergeant and four men of the engineer detachment, proceeding on the road to Carroll, while all the others started for the Judith. We reached Box Elder Station nine miles from camp, the edge of the Bad ^{Box Elder Creek.} Lands at sixteen miles, and Crooked Creek at thirty-two miles.

The day had been very hot and dusty, and we found no water between Box Elder and Crooked Creek. The bed of the creek was absolutely dry, and the single pool near the road had been trampled into a thick mud by the thirsty animals unhitched from two mule-trains and one bull-train, which had halted for the night on the creek. We had brought no water with us, and the prospects of a camp were wholly uninviting. About a mile farther down the ^{Camp in Bad Lands on Crooked Creek.} creek-bed I observed two or three cottonwood-trees, and an examination of the locality resulted in the pleasing discovery of three small but undisturbed pools of water, tepid and alkaline, but much better than none. The grass in the vicinity too, though exceedingly poor and thin, had not been grazed by the freight-trains. Numbers of antelope had been seen all day, and from the high ground on the edge of the Bad Lands small herds of buffalo dotted the broken landscape toward the river.

September 13.—Pulled out at 8 a. m. Crossed Little Crooked Creek, and soon after ascended upon the high, rolling prairie, winding over which the road eventually leads out upon a high, narrow ridge near the river, where, turning to the eastward, the steep descent of 900 feet ^{Return to Carroll.} is made into the river-valley, where Carroll is situated. It was ascertained that the boat would probably reach Carroll on the 19th, and leave next day.

There was a possibility that a later trip would be made; but, as this depended entirely upon the stage of water, which was very low and still falling, reliance could not be placed upon it. The week's heavy rains in the upper valleys had caused a rise of about six inches in the channel at Carroll, but this rise had been already exhausted, and more rain could hardly be looked for. I therefore dispatched a messenger to Lieutenant Thompson to be back in Carroll on the night of the 19th.

September 14.—Mr. Dana was desirous of examining the Little Rocky Mountains some thirty miles to the north and west, and we accordingly made preparations for a trip to them. The ambulance was placed in a Mackinac boat ready for transportation across the river in the morning.

September 15.—Crossed the river in the Mackinac, swimming the animals. The party consisted of Mr. Dana and myself and four men; one driving a pair of mules in the ambulance, ^{Trip to the Little Rocky Mountains.} which carried the rations and scanty allowance of bedding. Some of the Carroll

hunters at first wished to accompany us, but were afterward deterred by reports of Indians near the mountains. I did not altogether regret this; for a small party entirely under control might be safer than a larger one without discipline. In order to get the ambulance out of the boat, we dropped down stream a mile and a half to the "point" below on the north bank, whence a hay-road led up the hill, climbing the 800 or 900 feet of ascent which was necessary to reach the prairie above,

En route to Little Rocky Mountains.

thence winding along narrow ridges formed by the deeply-penetrating *coulés* and ravines setting back from the river-valley. Reaching the prairie, the Little Rockies were in full view, and we traveled rapidly toward them over a dry, stony, nearly level road, with a brief halt for water at a pool in an unnamed creek-bed. Reaching the margin of the high prairie overlooking Little Rocky Creek, the descent appeared precipitous and the valley below difficult to travel. We therefore proceeded directly toward the mountains, and took our chance of finding

Camp near the Little Rocky Mountains.

water. Approaching within three or four miles, a very good camp for our small party was found near some springs. There was no wood, but we were fortunate enough to find a few pieces of drift brought down from the mountains during a freshet, and buffalo.

Buffalo.

chips were abundant. Two or three herds of buffalo were grazing within sight, gradually moving off as they became aware of our presence, and the antelope were more numerous than I had ever seen them. Soon after sunset, the harvest moon swung its broad disk above the eastern horizon, and flooded the yellow prairie with almost the light of day, shining brilliantly all night from a cloudless sky. The air was still, and the temperature mild and pleasant. About midnight, the snorting of the horses aroused me, and I found the men all up to keep the buffalo which surrounded the camp from coming so near as to stampede our cattle. They were approaching us to get water from the springs upon which we were encamped. The animals loomed up huge and black in contrast with the yellow prairie, and were evidently in great numbers, as their deep rattling snorts and snuffles could be heard in all directions.

In the gray light of early dawn, an antelope, attracted by the white cover of the ambulance, walked nearly into camp, and furnished an excellent breakfast. It was a barren doe, very fat and tender, with small horns, an inch or two in length.

September 16.—Mr. Dana spent the day exploring and examining the mountains. Camp was broken at 8 with the intention of finding another farther east in a sort of bay in the south side of the range, where wood would be more convenient, and which should offer better protection in case the Indians should discover us.

The presence of buffalo in such great numbers, and the known propinquity of a large Indian camp some twenty-five or thirty miles to the eastward, on Pouchette Creek, induced *Little Rocky Mountains.* me to believe that a more concealed camp would be much safer. The party was so small that it would be just as well to remain undiscovered. Entering the valley, it was found full of buffalo and antelope. The adjacent *coulés* and ravines were thoroughly examined for water without success, and I finally concluded to return to last night's camp. This is ordinarily an injudicious thing to do; but the quiet demeanor of the buffalo induced me to believe that they had not recently been hunted. Sending the ambulance back to camp, I took one man, and entered a pass behind the prominent mountain, where a well-worn game-trail furnished a good path. The mountains are well wooded and some 1,200 or 1,500 feet in height, apparently destitute of running water at this season. At a narrow place in the trail, a buffalo was encountered, who, after an instant's halt, uttered a frightened snort, and whirling his huge bulk around with ludicrous suddenness, set off at full speed. A few deer were seen, but no elk or sign of any. The mountains, in fact, seem to be too destitute of water to abound in the ordinary game. Emerging from the pass directly north of and in view of camp, the bed of the stream which supplied the springs below was found to be dry and stony. High up on the mountain-slopes a herd of buffalo were grazing, and Mr. Dana was distinguished approaching them with his carbine. His shots killed one, and started the herd at headlong speed down the mountain. Hastily concealing ourselves in the bed of the stream, the herd swept past, losing two more of their number. I endeavored to overtake on horseback a calf, the mother of which had been killed, but my horse developed no great amount of speed, and the calf certainly did, skipping away from me with the utmost agility. We returned to camp and had a quiet night, though unpleasantly cold without tents, water freezing in the buckets.

September 17.—We had seen all that was necessary of the Little Rockies, and had more game than could be carried in; a prolonged stay might be attended with serious consequences, and camp was therefore broken at 8 for the return to Carroll. Indians encountered. Steering by compass, we had proceeded for a couple of hours, when we saw half a mile ahead three men engaged in skinning a buffalo. Observing us, they mounted and started off, but soon halted and began to approach us. They proved to be Indians, a small hunting-party from the large camp, and got us to understand that they wanted to go in to Carroll with us as soon as they could dispose of the buffalo they were occupied with and another farther on. Though not anxious for their society, I assented, intending, in case of the appearance of a large party, and having any trouble with them, to hold the three as a sort of hostage. They worked with great earnestness and skill; and, having loaded three ponies with beef in a very short space of time, two of them joined us. The head-man pointed northeast, to where he said were forty-five lodges of his people. He denied being a Sioux, but spoke the language too well to be anything else. Approaching the river opposite Carroll, the two Indians wanted Mr. Dana and myself to go directly down the bluff to the river with them; but as my rifle had become disabled by an accident, and the pistol Return to Carroll. cartridges were exhausted, their offer was declined. One of them wished to assure me that he was unarmed, and throwing back his blanket showed an empty pistol-holster, and said he had lost it running buffalo. The same movement, however, exhibited the handle of a pistol on the other side. Apparently disgusted at our refusal, they plunged down the hill out of sight, and eventually reached town first.

September 18.—Crossed the ambulance back to Carroll. The steamer Josephine was looked for hourly during the day.

September 19.—At 2 p. m., Lieutenant Thompson, Mr. Wood, and the wagon arrived, and a few hours later Messrs. Grinnell, Ludlow, and Reynolds reached town in a small Mack- Judith Basin party arrive. inac, with which they had descended the river from the Judith.

A march of forty-four miles in two days—September 12 and 13—had taken the party from the camp on Armell's Creek to the mouth of the Judith, where they remained two days, and returned to Carroll in four days. The lower portion of the Judith Basin is largely occupied by Mauvaises Terres, precipitous and forbidding, and very difficult to travel. A few interesting fossils were found; but the extent of the field and the limited time available prevented thorough search. A large camp of Gros Ventres was in the basin intending to winter there, and game was scarce. At 5 p. m., the Josephine reached Carroll and discharged.

September 20.—Boat took on 60 tons of freight, and left at 4.30 p. m. Lieutenant Thompson was instructed to take the cavalry escort and transportation to Ellis and to return to Saint Paul via the Union Pacific. Leave Carroll.

The subsequent journey down the river was uneventful. The stream was very low, with only 18 inches of water on Buffalo Rapids, and we were frequently aground. When within fifteen or twenty miles of Buford, we met the Key West and exchanged freights; the Josephine returning to Carroll to make one more trip.

September 26.—We left Buford on the Key West at 8 a. m., reached Bismarck on the 29th, and Saint Paul October 2. Fort Buford.

Thus terminated this most interesting trip, which had covered by rail, water, and on horseback thirty-three hundred miles of travel in ninety-three days through every variety of landscape, from the most forbidding to the grandest and most picturesque.

I beg leave to add the following suggestions relative to the National Park. The main points are such as would present themselves to any visitor capable of appreciating the wonders of the park, and have been in some cases anticipated in the remarks and recommendations of previous visitors. Nevertheless, a repetition of them can do no harm, and will at least show what the concurrent testimony on the subject is. Remarks and suggestions relative to National Park.

Congress, by an act approved March 1, 1872 (sections 2474 and 2475, Revised Statutes, appended hereto), set aside the area therein defined (and which intended to include all the more remarkable objects and scenery) as a national domain, and consecrated it to the enjoyment and improvement of all mankind. For this purpose, the park was placed under the control of the Sec-

retary of the Interior; but, unfortunately, the act provides no further practical measures for its improvement than authorizing the making of small temporary leases (the revenues from which should be devoted to the proper management and improvement of the park) and the promulgation of regulations mainly looking to the preservation of the game. I am not informed as to whether any such leases have been made; but it is certain that no expenditures have been made for the improvement of the park, nor even for its proper protection. Of the preservation of the game I will mention some facts further on. The park remains in the same wild, secluded condition in which it was discovered, a few squatters and hunters inhabiting it. The number of visitors is not great, but is yearly increasing, and is mainly made up from the inhabitants of the Montana towns. Until some railroad facilities shall make the journey less expensive and fatiguing, the people at large can hardly avail themselves of the "pleasuring ground" so provided. Meanwhile, however, those who from propinquity are able to do so are entering upon the possession of their privileges, and abusing them by the wanton destruction of what was intended to be for the edification of all.

Wanton destruction of curiosities in the Geyser Basin.

The treasures of art and beauty, cunningly contrived by the hand of nature, are in process of removal to territorial homesteads, and the proportion of material destroyed to that carried off is as ten to one. Hunters have for years devoted themselves to the slaughter of the game, until within the limits of the park it is hardly to be found. I was credibly informed by people on the spot, and personally cognizant of the facts, that during the winter of 1874 and 1875, at which season the heavy snows render the elk an easy prey, no less than from 1,500 to 2,000 of these, the largest and finest game animals in the country, were thus destroyed within a radius of fifteen miles of the Mammoth Springs. From this large number, representing an immense supply of the best food, the skins only were taken, netting to the hunter some \$2.50 or \$3 apiece; the frozen carcasses being left in the snow to feed the wolves or to decay in the spring. A continuance of this wholesale and wasteful butchery can have but one effect, viz, the extermination of the animal, and that, too, from the very region where he has a right to expect protection, and where his frequent inoffensive presence would give the greatest pleasure to the greatest number.

Slaughter of game.

The cure for these unlawful practices and undoubted evils can only be found in a thorough mounted police of the park. In the absence of any legislative provision for this, recourse can most readily be had to the already existing facilities afforded by the presence of troops in the vicinity and by the transfer of the park to the control of the War Department. Troops should be stationed to act as guards at the lake, the Mammoth Springs, and especially in the Geyser Basin. A couple of signal-sergeants might profitably be employed in keeping meteorological and geyser records, which would be of great interest and value.

Recommendation.

In time, with faithful supervision, the park could easily be made self-supporting. Franchises and leases will be valuable, and properly administered would furnish a revenue sufficient to proceed gradually with all the improvements required. But meanwhile, and before any improvements can be judiciously undertaken, an indispensable preliminary would be a thorough and accurate topographical survey, which, having been completed, would serve to indicate where roads and bridle-paths could best be opened or most improved. The boundaries of the park could at the same time be run and laid down upon the ground.

For this a small annual appropriation of from \$8,000 to \$10,000 should be made, and the survey might properly be under the charge of an engineer officer, who, while making his survey and map, might at the same time be turning his attention and devoting perhaps a certain sum to the selection and construction of better routes of travel. While it would not be possible at once to make the park practicable for vehicles, the pack-trails could be vastly improved at slight expense; the survey indicating the best routes. An observatory on Mount Washburne, with a wire to Bozeman, could be constructed cheaply, and furnish a starting-point whence all the higher peaks, and from them the intervening country, could be mapped. Rough bridges could be constructed where needed, and the worst portions of the trail corduroyed. This preliminary work accomplished, and about two seasons' work would be required for it, the yearly appropriation being continued, the roads could by degrees be made practicable for wagons and carriages. Lodging-places could be constructed at

the Mammoth Springs, the bridge, the falls, the lake, and the geyser basins, for the accommodation of visitors; and these, after the construction by the engineer officer, should be under the charge of an officer detailed to make constant inspections of them and of the detachments doing guard and police duty in the park. Visitors should be forbidden to kill any game. The hunters should have their arms and spoils confiscated, besides being liable to prosecution.

For the accomplishment of these purposes, it would certainly be most convenient and expedient to take advantage of the presence and organization of the military, and to intrust the care of the park, at least temporarily, to the War Department; at least until such time as a civilian superintendent, living in the park, with a body of mounted police under his orders, should suffice for its protection.

The day will come, and it cannot be far distant, when this most interesting region, crowded with marvels and adorned with the most superb scenery, will be rendered accessible to all; and then, thronged with visitors from all over the world, it will be what nature and Congress, for once working together in unison, have declared it should be, a National Park.

Respectfully submitted.

WILLIAM LUDLOW,
*Captain Corps of Engineers, U. S. A.,
 Chief Engineer Department of Dakota.*

The ASSISTANT ADJUTANT-GENERAL,
Department of Dakota, Saint Paul, Minn.

ACT APPROVED MARCH 1, 1872.

(Revised Statutes of the United States, sections 2474 and 2475.)

SEC. 2474. The tract of land in the Territories of Montana and Wyoming, lying near the head waters of the Yellowstone River, and described as follows, to wit, commencing at the junction of Gardiner's River with the Yellowstone River, and running east to the meridian passing ten miles east of the most eastern point of the Yellowstone Lake; thence south along said meridian to the parallel of latitude passing ten miles south of the most southern point of Yellowstone Lake; thence west along said parallel to the meridian passing fifteen miles west of the most western point of Madison Lake; thence north along said meridian to the latitude of the junction of the Yellowstone and Gardiner's Rivers; thence east to the place of beginning, is reserved and withdrawn from settlement, occupancy, or sale under the laws of the United States, and dedicated and set apart as a public park or pleasuring ground for the benefit and enjoyment of the people; and all persons who locate or settle upon, or occupy any part of the land thus set apart as a public park, except as provided in the following section, shall be considered trespassers and removed therefrom.

*Revised Statutes,
 sections 2474 and
 2475.*

SEC. 2475. Such public park shall be under the exclusive control of the Secretary of the Interior, whose duty it shall be, as soon as practicable, to make and publish such regulations as he may deem necessary or proper for the care and management of the same. Such regulations shall provide for the preservation from injury or spoliation of all timber, mineral deposits, natural curiosities, or wonders within the park, and their retention in their natural condition. The Secretary may, in his discretion, grant leases for building purposes, for terms not exceeding ten years, of small parcels of ground, at such places in the park as may require the erection of buildings for the accommodation of visitors; all of the proceeds of such leases, and all other revenues that may be derived from any source connected with the park to be expended under his direction in the management of the same, and the construction of roads and bridle-paths therein. He shall provide against the wanton destruction of the fish and game found within the park, and against their capture or destruction for the purpose of merchandise or profit. He shall also cause all persons trespassing upon the same to be removed therefrom, and generally is authorized to take all such measures as may be necessary or proper to fully carry out the objects and purposes of this section.

ASTRONOMICAL OBSERVATIONS FOR TIME AND LATITUDE AT CARROLL, CAMP
LEWIS, AND CAMP BAKER.

Observation for time.

Station, Carroll, Montana.—Date, July 12, 1875.—Object observed, Arcturus.—Sextant, Spencer Browning, 6536.—Chronometer, Bond & Son, 202.—Index error, $-60''$.—Observer, Wood.—Computer, Wood.

Double altitudes observed.	Corresponding times.	Latitude = L	= 47 35 00	Refraction = R	= 0 1 10
o ' "	h. m. s.	N. polar dist. = Δ	= 70 10 00	Parallax = P	= 0 0 00
74 50 00	18 54 25.	True altitude = A	= 37 08 20	Semi-diam. = Sd	= 0 0 00
	54 55.5	2 m = L + Δ + A	= 154 53 20	R, P, and Sd	= 1 1 10
	55 26.5	m	= 77 26 40	Observed 2 alt.	= 74 20 00
	55 57.	m—A	= 40 18 20	Index error	= - 1 00
	56 26.5	log cos m	= 9.3372319	2 alt. corrected	= 74 19 00
73 50 00	18 57 29.	log sin (m—A)	= 9.8108128	Altitude	= 37 09 30
74 20 00	18 55 56.9	log cos m sin (m—A)	= 19.1480447	R, P, and Sd	= - 1 10
		log cos L sin Δ	= 9.8024365	True alt. = A	= 37 08 20
		log sin² ½ p	= 19.3456082	log cos L	= 9.8289930
		log sin ½ p	= 9.6728041	log sin Δ	= 9.9734435
		½ p	= 28 05 02	log cos L sin A	= 9.8024365
		p in arc	= 56 10 04		
		p in time	= 3 44 40.27		
		* Δ	= 14 09 59.5		
		Equation of time	=		
		True time	= 17 54 39.77		
		Time by chron.	= 18 55 56.87		
		Chron. fast	= 1 01 17.1		

Determination of the latitude by observed double altitudes of Polaris off the meridian.

Station, Carroll, Montana.—Date, July 12, 1875.—Sextant, Spencer Browning.—Index error, $-60''$.—Chronometer, Bond & Son, 202.—Observer, Wood.—Computer, Wood.

[illegible]

Refraction.....	— 50"
Chron. correction.....	1 ^h 01 ^m 17.1
Dec.....	88° 38' 25"
Δ	4895"
<i>R</i> Polaris.....	<i>h.</i> <i>m.</i> <i>s.</i>
Sid. time at mean noon at this station.....	1 12 47.7
Sid. interval from mean time of culmination.....	
Retardation of mean on sidereal time.....	
Mean time of culmination of star.....	
Error of chron. at time of observation.....	1 01 17.1
Time by chron. of culmination.....	2 14 04.8
Sid. time of observation.....	19 22 08.5
Hour-angle, <i>p</i> , in mean time.....	6 51 56.3
Sidereal equivalents in arc.....	102° 59' 05"
<i>p</i> in arc.....	

Determination of latitude by circum-meridian altitudes.

Station, Carroll, Montana.—Date, September 20, 1875.—Object observed, ☉.—Sextant, Spencer Browning, 6536.—Index error, $-1' 15''$.—Chronometer, Arnold & Dent, 1362.—Observer, Wood.—Computer, Wood.—Bar., 27ⁱⁿ. 61.—Ther., 61°.

Times of obs. by chron.	Mer. dist. = p .	$\frac{2 \sin^2 \frac{1}{2} p}{\sin 1''}$ = k	$\frac{\cos l \cos D}{\cos a}$	Red. to mer. in arc = z .	Obs'd 2 cir- cum-meri- dian alti- tudes.	Obs'd alti- tudes, cor- rected for index error.	True alti- tudes = a .	True mer. alt's deduced = a + z = A .	Lat. deduced = $90^\circ + D - A$.
<i>h. m. s.</i>	<i>' "</i>	<i>"</i>	Constant multiplier, .93.	<i>"</i>	<i>° ' "</i>	<i>° ' "</i>	<i>° ' "</i>	<i>° ' "</i>	<i>° ' "</i>
12 50 43.	4 42.	43		40	86 24 50	43 11 47	43 26 56	43 27 36	47 34 51
51 12.	4 13.	35		33	87 29 00	43 52	27 05	27 36	49
51 42.5	3 42.5	27		25	86 25 30	12 07	27 16	27 41	46
52 18.5	3 06.5	19		18	87 29 50	44 17	27 30	27 48	39
52 47.	2 38.	14		13	86 25 50	12 17	27 26	27 39	48
53 14.5	2 10.5	9		9	87 30 00	44 22	27 35	27 44	43
53 39.	1 46.	6		6	86 25 40	12 12	27 21	27 27	60
54 15.	1 10.	3		3	87 30 10	44 27	27 40	27 43	44
54 53.5	31.5	0		0	86 26 00	12 22	27 31	27 31	56
55 27.	02.	0		0	87 30 00	44 22	27 35	27 35	52
55 50.	25.	0		0	86 25 50	12 17	27 26	27 26	61
56 19.5	54.5	2		2	87 29 50	44 17	27 30	27 32	55
56 46.	1 21.	4		4	86 25 40	12 12	27 21	27 25	62
57 24.5	2 00.	8		8	87 29 50	44 17	27 30	27 38	49
57 57.5	2 32.5	13		12	86 25 30	12 07	27 16	27 28	59
58 25.5	3 00.5	18		17	87 29 30	44 07	27 20	27 37	50
58 46.5	3 21.5	22		21	86 25 20	12 02	27 11	27 32	55
59 20.	3 55.	30		28	87 29 20	44 02	27 15	27 43	44
12 59 49.	4 24.	38		35	86 25 00	43 11 52	43 27 01	43 27 36	47 34 51
Mean latitude.....									47 34 51

App. Lat. = l	$47^\circ 35'$	$\cos 9.92899$	Chron. correction $-1^\circ 02' 04.16''$	Semi-diam. $+15' 58.5''$	$-15' 58.5''$
Dec. = d	$1^\circ 02' 27.3''$	$\cos 9.99993$	Equation of time $+6' 38.92''$	Refraction $-55.9''$	$-54.9''$
a	$43^\circ 28' 10''$	$\cos 0.13922$		Parallax $+6.3''$	$+6.3''$
		9.96814	$-55' 25.24''$	$+15' 09''$	$-16' 47''$

Determination of the time by observed equal altitudes of the sun's limb.

TO CORRECT THE CHRONOMETER AT NOON.

Station, Carroll, Montana.—Date, September 20, 1875.—Sextant, Spencer Browning, 6536.—Chronometer, Arnold & Dent, 1362.—Observer, Wood.—Computer, Wood.

Observed double altitude.	Corresponding times.		$t - t' =$ elapsed time.	Equation of equal altitudes = x .	Chron. fast of mean time at appt. noon by each pair of equal altitudes.
	A. M. = t	P. M. = t'			
<i>° ' "</i>	<i>h. m. s.</i>	<i>h. m. s.</i>	<i>h. m.</i>	<i>s.</i>	<i>h. m. s.</i>
72 10 00	10 51 40.5	2 58 34.5	4 2	+16.80	1 02 04.16
	52 04.5	58 10.5			
	52 29.	57 47.			
	52 51.5	57 23.			
	53 14.5	57 00.			
	53 38.	56 37.			
	54 03.	56 14.5			
	54 27.	55 50.			
	54 50.5	55 27.5			
	55 14.5	55 04.			
	55 38.5	54 42.			
	56 02.	54 16.5			
73 10 00	10 56 26.5	2 53 53.			

$T = 4^h 2m$	$\log A$ (page 164) = -9.4263	$\log B = +9.3627$	<i>h. m. s.</i>
$d = -58'' 33$	$\log d = -1.7659$	$\log d = -1.7659$	10 54 03.08
$L = 47^\circ 35'$	$\log \tan = 0.0392$	$\log \tan D = +8.2597$	14 56 13.81
1st term = $+17^\circ 04'$			25 50 16.89
2d term = $-0^\circ 24'$			12 55 08.44
$s = +16^\circ 8' =$ equation of equal altitudes.			16.80
			12 55 25.24 = eq. of time.
			11 53 21.08
			1 02 04.16

RECONNAISSANCE FROM CARROLL, MONTANA,

Observation for time.

Station, Camp Lewis, Montana.—Date, July 25, 1875.—Object observed, Altair.—Ref. Circle, Gambay and Son, 212.—Chronometer, Bond & Son, 202.—Observer, Wood.—Computer, Wood.—Bar., 25th 95.—Ther., 59°.

Double altitudes observed.			Corresponding times.								
o	'	"	h.	m.	s.				o	'	"
720	00	00	18	11	45.	Latitude = L	=	47	03	40	
67	58	20	12	30.5	N. polar dist. = Δ	=	81	27	35		
			13	32.	True altitude = A	=	39	23	52		
			14	28.5							
			15	20.	2 m = L + Δ + A	=	167	54	07		
			15	55.5	m	=	83	57	03		
			16	34.5	m—A	=	44	34	11		
			17	38.5	log cos m	=	9.0227658				
			18	31.5	log sin (m—A)	=	9.8461989				
			18	19	20.5						
			18	15	33.6	log cos m sin (m—A)	=	18.8689647			
						log cos L sin Δ	=	9.8284436			
						log sin ² $\frac{1}{2}$ p	=	19.0405211			
						log sin $\frac{1}{2}$ p	=	9.5202605			
						$\frac{1}{2}$ p	=	19	20	58	
						p in arc	=	38	41	56	
						p in time	=	2	34	47.7	
						* R	=	19	44	43.8	
						Equation of time	=				
						True time	=	17	09	56.1	
						Time by chron.	=	18	15	33.6	
						Chron. fast	=	1	05	37.5	

			o ' "		
Refraction = R	=				
Parallax = P	=				63
Semi-diam. = Sd	=				
R, P, and Sd	=				
Observed 2 alt.	=	78	47	50	
Index error	=				
2 alt. corrected	=	78	47	50	
Altitude	=	39	23	55	
R, P, and Sd	=		1	03	
True alt. = A	=	39	23	52	
log cos L	=	9.8332261			
log sin Δ	=	9.9951575			
log cos L sin Δ	=	9.8284436			

Observation for time.

Station, Camp Lewis, Montana.—Date, July 25, 1875.—Object observed, Arcturus.—Ref. Circle, Gambay & Son, 212.—Chronometer, Bond & Son, 202.—Observer, Wood.—Computer, Wood.—Bar, 25th 95.—Ther., 59°.

Double altitudes observed.			Corresponding times.			Latitude = L			= 47 03 40			Refraction = R			= 0 10 50		
o / "			h. m. s.			N. polar dist. = Δ			= 70 10 00			Parallax = P			= 0 00 00		
			59 00.			True altitude = A			= 46 36 46			Semi-diam. = Sd			= 0 00 00		
			59 54.5			2m = L + Δ + A			= 163 50 26			R, P, and Sd			= 0 00 00		
			18 01 19.5			m			= 81 55 13			Observed 2 alt			= 93 15 13		
			02 21.5			m - A			= 35 18 27			Index error			= 0 00 00		
			03 14.			log cos m			= 9.1473335			2 alt. corrected			= 93 15 13		
			04 13.5			log sin (m - A)			= 9.7619011			Altitude			= 46 37 36		
720 00 00			05 01.			log cos m sin (m - A)			= 18.9097346			R, P, and Sd			= 0 00 00		
212 32 10			06 09.			log cos L sin Δ			= 9.8067296			True alt. = A			= 46 36 46		
			18 07 02.			log sin ² ½ p			= 19.1030050			log cos L			= 9.8332661		
932 32 10						log sin ½ p			= 9.5515025			log sin Δ			= 9.9734435		
			18 02 25.5									log cos L sin Δ			= 9.8067296		
93 15 13						½ p			= 20 51 29								
						p in arc			= 41 42 54								
						p in time			= 2 46 51.6								
						*R			= 14 09 59.2								
						Equation of time			= 16 56 50.8								
						True time			= 18 02 25.5								
						Time by chron.			= 1 05 34.7								
						Chron. fast			= 1 05 34.7								

Determination of the latitude by observed double altitudes of Polaris off the meridian.

Station, Camp Lewis, Montana.—Date, July 25, 1875.—Ref. Circle, Gambay & Son, 212.—Chronometer, Bond & Son, 202.—Observer, Wood.—Computer, Wood.—Bar., 25th.95.—Ther., 58°.

Observed double altitudes.	Corresponding times.				
o ' "	h. m. s.	log cos p	= 9.5393086	log sin p	9.97228
18 50 45.5	18 50 45.5	log Δ	= 3.6895752	log Δ	3.68958
51 37.	51 37.	log Δ cos p	= 3.223-838	log Δ sin p	3.66186
52 44.5	52 44.5			log (Δ sin p) ²	7.32372
53 53.5	53 53.5			log a	4.38454
54 42.	54 42.			log tan A	0.02390
19 00 36.	19 00 36.	1st term	= 28 14	log 2d term	1.73225
01 30.5	01 30.5	Alt. = A	= 46 34 55	2d term	54"
02 30.5	02 30.5				
03 19.5	03 19.5	Latitude	= 47 04 03		
19 04 08.5	19 04 08.5				
931 55 00	18 57 34.75				
93 11 30					
46 35 45					
50					
46 34 55					

Refraction	50"
Chron. correction	1 ^h 05 ^m 36 ^s .1
Dec.	88° 33' 27"
Δ	4593"
At Polaris	h. m. s.
Sid. time at mean noon at this station	1 12 59.65
Sid. interval from mean time of culmination	
Retardation of mean on sidereal time	
Mean time of culmination of star	
Error of chron. at time of observation	1 05 36.10
Time by chron. of culmination	2 18 35.75
Clock-time of observation	18 57 34.75
Hour-angle, p, in sid. time	7 21 01.
Sidereal equivalents in arc	110° 15' 15"
p in arc	

Determination of latitude by circum-meridian altitudes.

Station, Camp Lewis, Montana.—Date, July 25, 1875.—Object observed, α Ophiuchi.—Sextant, Spencer Browning, 6536.—Index error, —20".—Chronometer, Bond & Son, 202.—Observer, Wood.—Computer, Wood.—Bar., 25th.95.—Ther., 58°.

Times of obs. by chron.	Mer. dist. = p.	$\frac{2 \sin^2 \frac{1}{2} p}{\sin 1''} = k$	$\cos l \cos D$ cos a	Red. to mer. in arc = z.	Obs'd 2 cir- cum-meridian altitudes.	Obs'd alti- tudes, cor- rected for index error.	True alti- tudes = a.	True mer. alt's deduced = a + z = A.	Lat. deduced = 90° + D - A.
h. m. s.	' "	"		' "	o ' "	o ' "	o ' "	o ' "	o ' "
18 26 45.5	8 00.5	126.		2 27	111 07 30	55 33 35	55 33 01	55 35 28	47 03 39
27 16.	7 30.	110.		2 08	08 40	34 10	33 30	44	13
27 44.	7 02.	97.		1 53	08 00	33 50	33 16	09	58
28 10.	6 36.	85.5		1 39	08 50	34 15	33 41	20	47
28 36.5	6 09.5	74.3		1 26	09 40	34 40	34 06	32	35
29 14.5	5 31.5	60.		1 10	10 10	34 55	34 21	31	36
29 45.5	5 00.5	49.		57	11 00	35 20	34 46	43	24
30 26.	4 20.	37.		43	11 20	35 30	34 56	39	28
30 54.	3 52.	29.		34	11 20	35 30	34 56	30	37
31 49.5	2 56.5	17.		20	11 30	35 35	35 01	21	46
32 19.	2 27.	12.		14	11 30	35 35	35 01	15	52
32 47.	1 59.	8.		9	11 50	35 45	35 11	20	47
33 22.5	1 23.5	4.		5	12 20	36 00	35 26	31	36
34 12.5	33.5	0.6		1	12 00	35 50	35 16	17	50
34 53.	7.	0.		0	12 50	36 15	35 41	41	26
35 38.5	52.5	1.5		2	12 00	35 50	35 16	18	49
36 16.5	1 30.5	4.5		5	12 00	35 50	35 16	21	46
36 50.5	2 04.5	8.5		10	12 10	35 55	35 21	31	36
37 30.	2 44.	14.7		17	12 00	35 50	35 16	33	34
38 01.5	3 15.5	21.		24	11 30	35 35	35 01	25	42
38 35.	3 49.	28.6		33	11 00	35 20	34 46	19	48
39 05.	4 19.	36.6		42	10 50	35 15	34 41	23	44
40 18.	5 32.	60.		1 10	10 30	35 05	34 31	41	26
40 47.5	6 01.5	71.		1 23	10 00	34 50	34 16	39	28
41 39.	6 53.	93.		1 48	09 40	34 40	34 06	54	13
42 10.	7 24.	107.5		2 03	08 00	33 50	33 16	19	48
42 42.5	7 56.5	124.		2 24	08 00	33 50	33 16	40	27
18 43 17.	8 31.	141.8		2 45	111 07 30	55 33 35	55 33 01	55 35 46	47 03 21
Mean									47 03 37

App. lat. = l	= 47 03 50.	cos 9.83326	Chron. correction	h. m. s.	Semi-diam.
Dec.	= 12 39 07.4	cos 9.99932	Δ of *	1 05 36	Refraction 34"
a	= 55 35 20.	cos 0.24785		17 29 10	Parallax
				18 34 46	
		0.07043			

RECONNAISSANCE FROM CARROLL, MONTANA,

Observation for time.

Station, Camp Lewis, Montana.—Date, September 10, 1875.—Object observed, Arcturus.—Sextant, Spencer Browning, 6536.—Chronometer, Bond & Son, 202.—Index error, 1' 20".—Observer, Wood.—Computer, Wood.—Bar., 25th. 75.—Ther., 50°.

Double altitudes observed.			Corresponding times.			Latitude = L			Refraction = R		
°	'	"	h.	m.	s.	°	'	"	°	'	"
60	40	00	20	02	08.	N. polar dist. = Δ	=	47 03 50	Parallax = P	=	1 26
				02	37.	True altitude = A	=	70 10 00	Semi-diam. = Sd	=	
				03	06.5			30 02 54	R, P, and Sd	=	
				03	36.	$2m = L + \Delta + A$	=	147 16 44	Observed 2 alt.	=	60 10 00
				04	05.	m	=	73 38 22	Index error	=	1 20
				04	35.5	m—A	=	43 35 28	2 alt. corrected	=	60 08 40
59	40	00	20	05	04.5	log cos m	=	9.4497575	Altitude	=	30 04 20
60	16	00	20	03	35.93	log sin (m—A)	=	9.8385388	R, P, and Sd	=	— 1 26
						log cos m sin (m—A)	=	19.2882963	True alt. = A	=	30 02 54
						log cos L sin Δ	=	9.8067069	log cos L	=	9.8332634
						log sin ² $\frac{1}{2} p$	=	19.4815894	log sin Δ	=	9.9734435
						log sin $\frac{1}{2} p$	=	9.7407947	log cos L sin Δ	=	9.8067069
						$\frac{1}{2} p$	=	33 24 16			
						p in arc	=	66 48 32			
						p in time	=	4 27 14.13			
						*R	=	14 09 58.65			
						Equation of time	=				
						True time	=	18 37 12.78			
						Time by chron.	=	20 03 35.93			
						Chron.	=	1 26 23.15			

Determination of the latitude by observed double altitudes of Polaris off the meridian.

Station, Camp Lewis, Montana.—Date, September 10, 1875.—Sextant, Spencer Browning, 6536.—Index error, —1' 20".—Chronometer, Bond & Son, 202.—Observer, Wood.—Computer, Wood.—Bar., 25th. 75.—Ther., 50°.

Observed double altitudes.			Corresponding times.								
°	'	"	h.	m.	s.	°	'	"	°	'	"
93	50	30	20	14	34.5	log cos p	=	8.9318631	log sin p	=	9.99841
51	20		15	31.		log Δ	=	3.6884198	log Δ	=	3.68842
52	00		16	35.		log Δ cos p	=	2.6202829	log Δ sin p	=	3.68683
53	50		18	25.				417".1			
54	10		19	53.5					log (As in p) ²	=	7.37366
55	10		20	32.					log a	=	4.35454
55	40		20	59.		1st term	=	6 57.1	log tan A	=	0.02931
56	00		21	37.		Alt. = A	=	46 55 55.	log 2d term	=	1.78751
56	10		22	12.		2d term	=	1 01.3	2d term	=	61".3
56	30		22	38.5		Latitude	=	47 03 53			
56	40		23	05.							
57	10		23	45.5							
93	57	30	20	24	17.5						
93	54	49	20	20	19.96						
1	20										
93	53	29									
46	56	45									
50											
46	55	55									

Refraction	50"
Chron. correction	1 ^h 26 ^m 23 ^s . 15
Dec	88° 38' 40"
Δ	4880"
R Polaris	h. m. s.
Sid. time at mean noon at this station	1 13 33.66
Sid. interval from mean time of culmination	
Retardation of mean on sidereal time	
Mean time of culmination of star	
Error of chron. at time of observation	1 26 23.15
Time by chron. of culmination	2 39 56.81
Clock-time of observation	20 20 19.96
Hour angle, p, in sid. time	6 19 36.85
Sidereal equivalents in arc	94° 54' 13"
p in arc	

Determination of the time by observed equal altitudes of the sun's limb.

TO CORRECT THE CHRONOMETER AT NOON.

Station, Camp Baker, Montana.—Date, July 31, 1875.—Sextant, Spencer Browning, 6536.—Chronometer, Arnold & Dent, 1362.—Observer, Wood.—Computer, Wood.

Observed double altitudes.	Corresponding times.		$t - t' =$ elapsed time.	Equation of equal altitudes = x .	Chron fast of mean time at appt. noon by each pair of equal altitudes.
	A. M. = t	P. M. = t'			
° ' "	<i>h. m. s.</i>	<i>h. m. s.</i>	<i>h. m.</i>	<i>s.</i>	<i>h. m. s.</i>
73 20 00	9 39 53.5	5 00 45.5	7 18	+9.60	1 14 21.94
	40 07.	00 30.5			
	40 23.5	00 15.			
	40 38.	00 00.5			
	40 52.5	4 59 45.5			
	41 07.	59 30.5			
	41 24.	59 16.5			
	41 37.5	59 01.			
	41 53.	58 45.5			
	42 08.5	58 31.			
	42 23.	58 16.			
	42 38.5	58 01.			
74 20 00	9 42 53.	4 57 46.			
	9 41 23.	4 50 15.73			

T = 7^h 18^m
 $\delta = 37^{\circ} 03'$
 L = 46^o 40' 40"
 1st term = +1^h. 70
 2d term = -2^h. 10

log A (page 164) = -9.4742
 log δ = -1.5687
 log tan = 0.0254
 = +1.0653

log B = 9.2355
 log δ = -1.5687
 log tan D = 9.5182
 = -0.3224

h. m. s.
 16 59 15.73
 9 41 23.
 26 40 38.73
 13 20 19.36
 + 9.60
 13 20 28.96
 12 06 07.02
 1 14 21.94

 $x = +9^h.60 =$ equation of equal altitudes.*Determination of latitude by circum-meridian altitudes.*Station, Camp Baker, Montana.—Date, July 31, 1875.—Object observed, ☉.—Sextant, Spencer Browning, 6536.—Index error, -50".—Chronometer, Arnold & Dent, 1362.—Observer, Wood.—Computer, Wood.—Bar., 25^h. 20.—Ther., 85°.

Times of obs. by chron.	Mer dist. = p .	$\frac{2 \sin^2 \frac{1}{2} p}{\sin 1''} = k$.	$\cos l \cos D \cos a$.	Red. to mer. in arc = x .	Obs'd 2 circum-meridian altitudes.	Obs'd altitudes, corrected for index error.	True altitudes = a .	True mer. alt's deduced = $a + x = A$.	Lat. deduced = $90^{\circ} + D - A$.
<i>h. m. s.</i>	' "	"		' "	° ' "	° ' "	° ' "	° ' "	° ' "
1 10 37.5	9 51.5	190.8	Constant multiplier, 1.368.	4 21	123 33 10	61 46 10	61 30 01	61 34 22	46 40 43
1 11 11.5	9 17.5	169.5		3 52	122 30 50	61 15 00	61 30 27	34 19	40 46
11 43.	8 46.	151.0		3 25	123 34 50	61 47 00	30 51	74 16	40 49
12 12.	8 17.	134.7		3 04	122 32 00	61 15 35	31 02	34 06	40 59
12 35.5	7 53.5	122.2		2 50	123 35 50	61 47 30	31 21	34 11	40 54
13 01.5	7 27.5	109.3		2 29	122 32 50	61 16 00	31 27	33 56	40 69
13 42.5	6 46.5	90.0		2 03	123 37 20	61 42 15	32 06	34 09	40 56
14 19.5	6 09.5	74.5		1 42	122 35 00	61 17 05	32 32	34 14	40 51
14 47.5	5 41.5	63.6		1 27	123 38 40	61 48 55	32 46	34 13	40 52
15 22.5	5 06.5	51.2		1 10	122 35 40	61 17 25	32 52	34 02	40 63
16 03.	4 28.	38.6		53	123 40 20	61 49 45	33 36	34 29	40 36
16 31.	3 58.	31.0		42	122 36 30	61 17 50	33 17	33 59	40 66
17 06.5	3 22.5	22.4		31	123 41 00	61 50 05	33 56	34 27	40 38
17 47.	2 42.	14.3		20	122 37 10	61 18 10	33 37	33 57	40 68
18 15.	2 14.	9.8		13	123 41 20	61 50 15	34 06	34 19	40 46
18 45.5	1 43.5	5.8		8	122 37 50	61 18 30	32 57	34 05	40 60
19 21.5	1 07.5	2.4		3	123 42 10	61 50 40	34 31	34 34	40 31
19 55.	34.	0.6		1	122 38 10	61 18 40	34 07	34 08	40 57
20 32.	3.	0.0		0	123 42 00	61 50 35	34 26	34 26	40 39
20 58.5	29.5	0.5		1	122 38 00	61 18 35	34 02	34 03	40 62
21 33.5	1 04.5	2.3		3	123 42 00	61 50 35	34 26	34 29	40 36
22 16.	1 47.	6.3		8	122 38 00	61 18 35	34 02	34 10	40 55
22 44.5	2 15.5	10.0		14	123 41 20	61 50 15	34 06	34 20	40 45
23 23.5	2 54.5	16.6		23	122 37 20	61 18 15	33 42	34 05	40 60
23 55.	3 26.	23.0		32	123 41 10	61 50 10	34 01	34 33	40 32
24 32.	4 03.	32.2		44	122 36 40	61 17 55	33 22	34 06	40 59
25 00.	4 31.	40.1		55	123 40 40	61 49 55	33 46	34 41	40 24
25 30.5	5 01.5	49.5		1 08	122 36 00	61 17 35	33 02	34 10	40 55
25 56.	5 27.	58.3		1 19	123 39 00	61 49 05	32 56	34 15	40 50
26 21.5	5 52.5	67.8		1 33	122 34 50	61 17 00	32 27	34 00	40 65
26 52.	6 23.	80.0		1 49	123 37 30	61 48 20	32 11	34 00	40 65
27 24.5	6 55.5	94.1		2 09	122 34 30	61 16 50	32 17	34 26	40 39
27 57.5	7 28.5	109.7		2 30	123 37 30	61 48 20	32 11	34 41	40 24
28 29.5	8 00.5	126.0		2 52	122 32 20	61 15 45	31 12	34 04	40 61
29 11.5	8 42.5	149.0		3 24	123 35 10	61 47 10	31 01	34 25	40 40
29 42.5	9 13.5	167.0		3 42	122 39 40	61 14 55	30 22	34 10	40 55
30 12.	9 43.	185.4		4 14	123 33 20	61 46 15	30 06	34 20	40 45
1 30 41.5	10 12.5	204.5		4 40	122 29 20	61 14 15	61 29 42	61 34 22	46 40 43
Mean									46 40 49

90 App. lat. = $l = 46^{\circ} 40'$ cos 9.83639 Chron. correction *h. m. s.* 1 14 21.94
 18 15 05 Dec. = $18^{\circ} 15' 05''$ cos 9.97758 Equation of time 6 07.02
 108 15 05 $a = 41^{\circ} 33'$ cos 0.32204 Semi-diam. - 15 47.9 + 15 47.9
 Refraction - 24.9 - 24.9
 Parallax + 4.2 + 4.2
 1 20 28.96 - 16 08.6 + 15 27.2

1.3677 0.13601

RECONNAISSANCE FROM CARROLL, MONTANA,

Determination of the latitude by observed double altitudes of Polaris off the meridian.

Station, Camp Baker, Montana—Date, July 31, 1875.—Ref. Circle, Gambay & Son, 212.—Chronometer, Bond & Son, 202.—Observer, Wood.
 Computer, Wood.—Bar., 25ⁱⁿ.24.—Ther., 60°.

Observed double altitudes.			Corresponding times.								
o	'	"	h.	m.	s.	log cos p	=	9.6527431	log sin p	=	9.95098
			18	35	49.5	log Δ <th>=</th> <th>3.6894864</th> <td>log Δ</td> <th>=</th> <th>3.68949</th>	=	3.6894864	log Δ	=	3.68949
				36	48.						
				37	22.	log Δ cos p <th>=</th> <th>3.3422295</th> <td>log Δ sin p</td> <th>=</th> <th>3.64047</th>	=	3.3422295	log Δ sin p	=	3.64047
				37	57.			2199"			
				38	22.5						
				38	53.				log (Δ sin p) ²	=	7.28094
				39	23.	1st term	=	36 39	log a	=	4.38454
				40	32.	Alt. = A	=	46 03 21	log tan A	=	0.01601
				41	19.5	2d term	=	48	log 2d term	=	1.68149
720	40	00	18	41	54.				2d term	=	48"
201	22	20				Latitude	=	46 40 48			
921	21	20	18	38	50.05						
92	08	14									
46	04	07									
		46									
46	03	21									

Refraction	46"
Chron. correction	— 1 ^m 12 ^m 3 ^m .05
Dec	1° 21' 32"
Δ	4892"

At Polaris	h. m. s.
Sid. time at mean noon at this station	1 13 05
Sid. interval from mean time of culmination	
Retardation of mean on sidereal time	
Mean time of culmination of star	
Error of chron. at time of observation	1 12 35
Time by chron. of culmination	2 25 40
Clock-time of observation	18 38 50
Hour-angle, p, in sid. time	7 46 50
Sidereal equivalents in arc	116° 42' 30"
p in arc	

Determination of latitude by circum-meridian altitudes.

Station, Camp Baker, Montana.—Date, August 1, 1875.—Object observed, ☉.—Sextant, Spencer Browning, 6536.—Index error, —33".—Chronometer, Arnold & Dent, 1302.—Observer, Wood.—Computer, Wood.—Bar., 25ⁱⁿ.20.—Ther., 85°.

Times of obs. by chron.	Mer. dist. = <i>p</i> .	$2 \sin^2 \frac{1}{2} p$ = <i>k</i> .	$\cos l \cos D$ $\cos a$	Red. to mer. in arc = <i>z</i> .	Obs'd 2 cir- cum-meri- dian alti- tudes.	Obs'd alti- tudes, cor- rected for index error.	True alti- tudes = <i>a</i> .	True mer. alt's deduced = <i>a</i> + <i>z</i> = <i>A</i> .	Lat. deduced = $90^\circ + D - A$.
<i>h. m. s.</i>	<i>' "</i>	<i>"</i>	Constant multiplier, 1.36.	<i>' "</i>	<i>° ' "</i>	<i>° ' "</i>	<i>° ' "</i>	<i>° ' "</i>	<i>° ' "</i>
1 14 17.	6 09	74.3		1 41	122 05 00	61 02 13	61 17 40	61 19 21	46 40 44
14 53.5	5 33	60.5		1 22	123 08 30	61 33 59	61 17 50	61 19 12	46 40 53
15 40.5	4 46	44.6		1 01	122 06 40	61 03 03	61 18 30	61 19 31	46 40 34
16 26.	4 00	31.4		43	123 09 40	61 34 34	61 18 25	61 19 08	46 40 57
16 48.	3 38	26.0		35	122 06 40	61 03 03	61 18 30	61 19 05	46 40 60
17 21.5	3 05	18.7		25	123 10 30	61 34 59	61 18 50	61 19 15	46 40 50
17 49.	2 37	13.4		18	122 07 20	61 03 23	61 18 50	61 19 08	46 40 57
18 31.5	1 53	7.0		9	123 10 40	61 35 04	61 18 55	61 19 04	46 40 61
19 11.5	1 15	3.0		4	122 07 40	61 03 33	61 19 00	61 19 04	46 40 61
19 40.	46	1.0		1	123 11 10	61 35 19	61 19 10	61 19 11	46 40 54
20 13.5	13	0.0		0	122 08 00	61 03 43	61 19 10	61 19 10	46 40 55
20 44.	18	0.0		0	123 11 10	61 35 19	61 19 10	61 19 10	46 40 55
21 09.5	43	1.0		1	122 07 50	61 03 36	61 19 03	61 19 04	46 40 61
21 40.5	1 14	3.0		4	123 11 00	61 35 14	61 19 05	61 19 09	46 40 56
22 04.	1 38	5.2		7	122 07 50	61 03 36	61 19 03	61 19 10	46 40 55
22 36.	2 10	9.2		12	123 10 40	61 35 04	61 18 55	61 19 07	46 40 58
23 09.	2 43	14.5		20	122 07 10	61 03 18	61 18 45	61 19 05	46 40 60
23 41.	3 15	20.7		25	123 10 10	61 34 48	61 18 39	61 19 07	46 40 58
24 25.	3 50	31.1		42	122 06 40	61 03 03	61 18 30	61 19 12	46 40 53
25 02.	4 36	41.5		56	123 09 20	61 34 24	61 18 15	61 19 11	46 40 54
25 38.	5 12	53.1		1 12	122 05 30	61 02 28	61 17 55	61 19 07	46 40 58
26 05.	5 39	62.7		1 25	123 08 30	61 33 59	61 17 50	61 19 15	46 40 50
26 29.5	6 03	71.9		1 38	122 04 40	61 02 03	61 17 30	61 19 08	46 40 57
1 26 48.5	6 22	79.6		1 48	123 07 40	61 33 34	61 17 25	61 19 13	46 40 52
					24) 15 12	122 38 20			
						33			
					38	2) 122 37 47			
						61 18 53.5			
						21			
						61 18 32.5			
						38			
						61 19 10.5			
						108 00 04.7			
						46 40 54.2			
Mean.....									
									46 40 54.4

90 00 00.0	App. lat. = l =	46 40 45.	\cos 9.83638
18 00 04.7	Dec. =	18 00 04.7	\cos 9.97820
108 00 04.7	a	61 18 30.	\cos 0.31867
61 19 21.			0.13325

Chron. correction	<i>h. m. s.</i>
Equation of time	1 14 22.38
	6 03.83
	1 20 26.21

Semi-diam.	— 15 48.	+ 15 48.
Refraction	— 25.2	— 25.2
Parallax	+ 4.2	+ 4.2
	— 16 09.	+ 15 27.

RECONNAISSANCE FROM CARROLL, MONTANA,

Determination of latitude by circum-meridian altitudes.

Station, Camp Baker, Montana.—Date, August 3, 1875.—Object observed, \odot .—Sextant, Spencer Browning, 6536.—Index error, $-25''$.—Chronometer, Arnold & Dent, 1362.—Observer, Wood.—Computer, Wood.—Bar., 25th. 20.—Ther., 86°.

Times of obs. by chron.	Mer. dist. = p .	$\frac{2 \sin^2 \frac{1}{2} p}{\sin 1''} = k$.	$\cos l \cos D \cos \alpha$.	Red. to mer. in arc = z .	Obs'd 2 circum-meridian altitudes.	Obs'd altitudes, corrected for index error.	True altitudes = α .	True mer. alt's deduced = $a + z = A$.	Lat. deduced = $90^\circ + D - A$.
<i>h. m. s.</i>	<i>' "</i>	<i>"</i>		<i>' "</i>	<i>° ' "</i>	<i>° ' "</i>	<i>° ' "</i>	<i>° ' "</i>	<i>° ' "</i>
1 12 59.5	7 20	105.6	Constant multiplier, 1.385.	2 26	122 05 00	61 02 17	61 46 07	61 48 33	46 40 38
13 28.5	6 51	92.1		2 07	121 02 20	60 30 58	46 25	48 32	39
13 53.5	6 26	81.3		1 53	122 06 00	61 02 47	46 37	48 30	41
14 24.5	5 55	68.7		1 35	121 03 10	60 31 23	46 50	48 25	46
14 51.5	5 28	58.7		1 21	122 07 00	61 03 17	47 07	48 28	43
15 23.	4 56	47.8		1 06	121 04 10	60 31 53	47 20	48 26	45
16 01.	4 18	36.3		50	122 08 10	61 03 52	47 42	48 32	39
16 32.	3 47	28.1		39	121 05 00	60 32 18	47 45	48 24	47
17 00.	3 19	21.6		29	122 08 40	61 04 07	47 57	48 26	45
17 27.5	2 52	16.1		22	121 05 30	60 32 33	48 00	48 22	49
18 04.5	2 15	10.0		14	122 09 40	61 04 37	48 27	48 41	30
18 28.	1 51	6.7		9	121 05 30	60 32 33	48 00	48 09	62
19 00.5	1 19	3.4		4	122 09 50	61 04 42	48 32	48 36	35
19 30.5	49	1.3		1	121 06 20	60 32 58	48 25	48 26	45
20 00.5	19	0.0		0	122 09 40	61 04 37	48 27	48 27	44
20 30.5	11	0.0		0	121 06 10	60 32 53	48 20	48 20	51
21 52.5	1 33	4.7		6	122 09 20	61 04 27	48 17	48 23	43
22 37.	2 18	10.4		14	121 05 40	60 32 38	48 05	48 19	52
23 09.	2 50	15.8		22	122 09 00	61 04 17	48 07	48 29	42
23 34.	3 15	20.7		29	121 05 20	60 32 28	47 55	48 24	47
24 03.	3 44	27.4		38	122 08 20	61 03 57	47 47	48 25	46
24 36.	4 17	36.0		50	121 04 50	60 32 13	47 40	48 30	41
25 08.	4 49	45.5		1 03	122 07 40	61 03 37	47 27	48 30	41
25 50.	5 31	58.8		1 22	121 03 30	60 31 33	47 00	48 22	49
26 42.5	6 23	80.0		1 51	122 06 10	61 02 52	46 42	48 33	38
27 14.5	6 55	94.0		2 10	121 02 00	60 30 48	61 46 15	61 48 25	46 40 46
Mean									46 40 44
90 00 00	App. lat. = l	$46 40 40$	$\cos 9.83648$	Chron. correction	$1 14 23.7$	Semi-diam.	$- 15 48.3$	$+ 15 48.3$	
17 29 11	Dec.	$17 29 11$	$\cos 9.97945$	Equation of time	$5 55.5$	Refraction	$- 25.6$	$- 25.6$	
	a	$61 48$	$\cos 0.32555$		$1 20 9.2$	Parallax	$+ 4.3$	$+ 4.3$	
107 29 11			1.385				$- 16 09.6$	$+ 15 27.0$	
61 48 33			0.14148						
46 40 38									

Determination of latitude by circum-meridian altitudes.

Station, Camp Baker, Montana.—Date, August 4, 1875.—Object observed, α Ophiuchi.—Sextant, Spencer Browning, 6536.—Chronometer, Bon & Son, 202.—Observer, Wood.—Computer, Wood.—Bar., 25th. 22.—Ther., 57°.

Times of obs. by chron.	Mer. dist. = p .	$\frac{2 \sin^2 \frac{1}{2} p}{\sin 1''} = k$.	$\cos l \cos D \cos \alpha$.	Red. to mer. in arc = z .	Obs'd 2 circum-meridian altitudes.
<i>h. m. s.</i>	<i>' "</i>	<i>"</i>		<i>' "</i>	<i>° ' "</i>
18 31 34.	10 12.	204.2	Constant multiplier, 1.196.	85.1	111 50 40
32 20.	9 26.	174.7			51 30
33 07.5	8 38.5	146.6			53 00
33 51.	7 55	123.1			53 50
34 32.5	7 13.5	102.5			54 50
35 09.	6 37.	86.0			55 20
36 11.	5 35.	61.2			56 00
37 14.5	4 31.5	40.2			56 50
38 06.	3 40.	26.4			57 30
38 43.5	3 02.5	18.2			58 00
39 22.	2 24.	11.3			58 10
40 13.	1 33.	4.7			58 20
41 00.5	45.5	1.1			58 50
41 53.5	07.5	0.0			58 20
42 54.	1 08.	2.5			58 30
43 51.5	2 05.5	8.6			58 20
44 38.5	2 52.5	16.2			58 10
45 25.	3 39.	26.2			57 50
46 10.	4 24.	38.0			56 40
46 55.5	5 09.5	52.3			56 20
47 32.5	5 46.5	65.5			56 00
48 16.	6 30.	83.0			55 10
48 53.	7 07.	99.7			54 20
49 31.	7 45.	117.9			54 00
50 34.5	8 48.5	152.3			52 30
18 51 32.	9 46.	187.3			111 51 50
		71.14			111 55 48
					60
					111 54 48
					55 57 24
					32
					55 56 52
					1 25.1
					55 58 17.1
					102 39 08.6
					46 40 51.5
App. lat. = l	$46 40 40$	$\cos 9.83648$	Chron. correction	$1 19 35.65$	Semi-diam.
Dec.	$12 39 08.6$	$\cos 9.98932$	* R	$17 29 10.38$	Refraction — $32''$
a	$55 57$	$\cos 0.25188$	Equation of time	$18 41 46.03$	Parallax
	1.196	0.07768			

Determination of the latitude by observed double altitudes of Polaris off the meridian.

Station, Camp Baker, Montana.—Date, August 4, 1875.—Ref. Circle, Gambay & Son, 212.—Chronometer, Bond & Son, 202.—Observer, Wood.—Computer, Wood.—Bar., 25ⁱⁿ.22.—Ther., 57°.

Observed double altitudes.			Corresponding times.							
o	'	"	h.	m.	s.	log cos p	=	9.2947207	log sin p	9.991395
			19	37	17.	log Δ <th>=</th> <th>3.6893977</th> <th>log Δ</th> <th>3.689398</th>	=	3.6893977	log Δ	3.689398
				37	59.5					
				38	48.	log Δ cos p <th>=</th> <th>2.9841184</th> <td>log Δ sin p</td> <th>3.680783</th>	=	2.9841184	log Δ sin p	3.680783
				39	26.			964".1		
				39	58.5					
				40	32.					
				41	17.5	1st term <th>=</th> <td>16 04.1</td> <td>log (Δ sin p)²</td> <td>7.36159</td>	=	16 04.1	log (Δ sin p) ²	7.36159
				41	53.	Alt. = A <th>=</th> <td>46 24 05.</td> <td>log a</td> <td>4.38454</td>	=	46 24 05.	log a	4.38454
				42	25.	2d term <th>=</th> <td>58.5</td> <td>log tan A</td> <td>.02125</td>	=	58.5	log tan A	.02125
208 17 00			19	42	56.				log 2d term	1.76738
720 00 00									2d term	58".5
10) 928 17 00			19	40	15.25	Latitude <th>=</th> <td>46 41 07.6</td> <td></td> <td></td>	=	46 41 07.6		
	92	49 42								
	46	24 51								
		46								
	46	24 05								

Refraction	46 ⁱⁿ
Chron. correction	1 ^h 12 ^m 35.65
Dec.	88° 38' 29 ⁱⁿ
Δ	4891 ⁱⁿ
<i>R</i> Polaris	h. m. s.
Sid. time at mean noon at this station	1 13 08.00
Sid. interval from mean time of culmination	
Retardation of mean on sidereal time	
Mean time of culmination of star	
Error of chron. at time of observation	1 12 35.65
Time by chron. of culmination	2 25 43.65
Clock-time of observation	19 40 15.25
Hour-angle, <i>p</i> , in sid. time	6 45 28.4
Sidereal equivalents in arc	101° 22' 06 ⁱⁿ
<i>p</i> in arc	

Determination of latitude by circum-meridian altitudes.

Station, Camp Baker, Montana.—Date, August 4, 1875.—Object observed, η Serpentis.—Sextant, Spencer Browning, 6536.—Index error, —30ⁱⁿ.—Chronometer, Bond & Son, 202.—Observer, Wood.—Computer, Wood.—Bar., 25ⁱⁿ.22.—Ther., 57°.

Times of obs. by chron.	Mer. dist. = <i>p</i> .	$\frac{2 \sin^2 \frac{1}{2} p}{\sin 1''} = k$.	$\cos l \cos D$ $\cos \alpha$	Red. to mer. in arc = <i>z</i> .	Obs'd 2 circum-meridian altitudes.
h. m. s.	i	"			o i "
19 23 18.5	4 10.5	34.3	Constant multiplier, .879.	13	80 49 00
24 07.	3 22.	22.3			49 00
24 49.	2 40.	14.0			49 00
25 37.5	1 41.5	5.7			49 10
26 42.5	46.5	1.2			49 10
27 19.5	09.5	.0			49 30
28 01.	32.	.6			49 30
28 42.	1 13.	2.9			49 20
29 19.	1 50.	6.6			49 10
30 04.5	2 35.5	13.2			49 00
30 46.	3 17.	21.2			49 00
31 24.	3 55.	30.1			48 10
19 32 11.	4 42.	43.4			80 47 40
		15.0			80 48 58
					30
					80 48 28
					40 24 14
					57
					40 23 17
					13
					40 23 30
					87 04 12
					46 40 42

App. lat. = <i>l</i> =	46 40 40.	cos 9.83648	Chron. correction	h. m. s.	Semi-diam.
Dec. =	8. 2 55 48.3	cos 9.99943	* <i>R</i>	18 14 53.22	Refraction 57 ⁱⁿ
α =	40 23 20.	cos 0 11824		19 27 28.87	Parallax
	.879	9.94415			

RECONNAISSANCE FROM CARROLL, MONTANA,

Observation for time.

Station, Camp Baker, Montana.—Date, August 5, 1875.—Object observed, Altair.—Ref. circle, Gambay & Son, 212.—Chronometer, Bond & Sons, 202.—Observer, Wood.—Computer, Wood.—Bar., 25ⁱⁿ.30.—Ther., 53°.

Double altitudes observed.	Corresponding times.	Latitude = L	°	'	"	Refraction = R	"
° ' "	<i>h. m. s.</i>	N. polar dist. = Δ	46	40	40	Parallax = P	56.8
	18 24 55.5	True altitude = A	81	27	33	Semi-diam. = Sd	
	25 47.5		40	19	44	R, P, and Sd	
	26 16.	$2m = L + \Delta + A$	168	27	57	Observed 2 alt.	
	27 06.5	<i>m</i>	84	13	58.5	Index error	
	27 37.	<i>m</i> —A	43	54	14.5	2 alt. corrected	
	28 07.5	log cos <i>m</i>	9.0021000			Altitude	
	28 40.	log sin (<i>m</i> —A)	9.8410167			R, P, and Sd	
	29 15.5					True alt. = A	
86 53 30		log cos <i>m</i> sin (<i>m</i> —A)	18.8431167			log cos L	9.8363878
720 00 00	18 30 24.5	log cos L sin Δ	9.8315447			log sin Δ	9.9951569
806 53 30	18 27 47.6	log sin ² $\frac{1}{2}p$	19.0115720			log cos L sin Δ	9.8315447
80 41 21		log sin $\frac{1}{2}p$	9.5057860				
40 20 40.5		$\frac{1}{2}p$	18 41 29				
40 19 44		<i>p</i> in arc	37 22 58				
		<i>h. m. s.</i>					
		<i>p</i> in time	2 29 31.87				
		* Δ	19 44 43.9				
		True time	17 15 12.				
		Time by chron.	18 27 47.6				
		Chron. fast	1 12 35.6				

Observation for time.

Station, Camp Baker, Montana.—Date, August 5, 1875.—Object observed, Arcturus.—Ref. circle, Gambay & Son, 212.—Chronometer, Bond & Son, 202.—Observer, Wood.—Computer, Wood.—Bar., 25ⁱⁿ.30.—Ther., 53°.

Double altitudes observed.	Corresponding times.	Latitude = L	°	'	"	Refraction = R	"
° ' "	<i>h. m. s.</i>	N. polar dist. = Δ	46	40	40	Parallax = P	58
	18 51 44.	True altitude = A	70	10	00	Semi-diam. = Sd	
	52 56.5		39	25	30	R, P, and Sd	
	53 30.	$2m = L + \Delta + A$	156	16	10	Observed 2 alt.	
	54 07.	<i>m</i>	78	08	05	Index error	
	54 34.	<i>m</i> —A	38	42	35	2 alt. corrected	
	54 59.5	log cos <i>m</i>	9.3130467			Altitude	
	55 29.	log sin (<i>m</i> —A)	9.7961406			R, P, and Sd	
	55 55.5					True alt. = A	
	56 28.5	log cos <i>m</i> sin (<i>m</i> —A)	19.1091873			log cos L	9.8363878
	56 55.5	log cos L sin Δ	9.8098313			log sin Δ	9.9734435
10)788 49 30	18 54 39.95	log sin ² $\frac{1}{2}p$	19.2993560			log cos L sin Δ	9.8098313
78 52 57		log sin $\frac{1}{2}p$	9.6496780				
39 26 28.0		$\frac{1}{2}p$	26 30 36				
39 25 30		<i>p</i> in arc	53 01 12				
		<i>h. m. s.</i>					
		<i>p</i> in time	3 32 04.8				
		* Δ	14 09 59.1				
		True time	17 42 03.9				
		Time by chron.	18 54 39.95				
		Chron. fast	1 12 36.0				

Determination of latitude by circum-meridian altitudes.

Station, Camp Baker, Montana.—Date, August 5, 1875.—Object observed, α Ophiuchi.—Ref. circle, Gambay & Son, 212.—Chronometer, Bond & Son, 202.—Observer, Wood.—Computer, Wood.—Bar., 25th. 30.—Ther., 53°.

Times of obs. by chron.	Mer. dist. = p .	$\frac{2 \sin^2 \frac{1}{2} p}{\sin 1''} = k$.	$\frac{\cos l \cos D}{\cos a}$	Red. to mer. in arc = z .	Observed 2 cir- cum-meridian alti- tudes.
<i>h. m. s.</i>	' "	"		"	<i>o ' "</i>
18 35 33.5	6 13	75.9	Const't multiplier, 1.196.	40.8	
37 54.5	3 52	29.4			
38 51.	2 55	16.7			
39 51.	1 55	7.2			
40 52.5	54	1.6			
41 59.5	13	-----			
43 10.5	1 24	3.9			
44 18.	2 32	12.6			
45 17.	3 31	24.3			
46 41.	4 56	47.8			
47 58.5	6 12	75.5			
18 49 24.	7 38	114.4			
		34.1			
					623 26 40
					720 00 00
					12)1343 26 40
					111 57 13.3
					55 58 36.6
					33
					55 58 03.6
					40.8
					55 58 44.4
					102 39 08.7
					46 40 24

App. lat. = l	<i>o ' "</i>			<i>h. m. s.</i>	
Dec.	= 46 40 40	cos 9.83648	Chron. correction	1 12 35.8	Semi-diam.
a	= 12 39 08.7	cos 9.98932	Equation of time	17 29 10.4	Refraction 33"
	= 55 58	cos 0.25206		18 41 46.2	Parallax
	1.196	0.07786			

Determination of latitude by circum-meridian altitudes.

Station, Camp Baker, Montana.—Date, August 5, 1875.—Object observed, γ Serpentis.—Ref. circle, Gambay & Son, 212.—Chronometer, Bond & Son, 202.—Observer, Wood.—Computer, Wood.—Bar., 27th. 30.—Ther., 53°.

Times of obs. by chron.	Mer. dist. = p .	$\frac{2 \sin^2 \frac{1}{2} p}{\sin 1''} = k$.	$\frac{\cos l \cos D}{\cos a}$	Obs'd 2 circum- meridian alti- tudes.
<i>h. m. s.</i>	' "	"		<i>o ' "</i>
19 23 15.	4 14.	35.2	Constant multiplier, .879.	
24 53.5	2 35.5	13.2		
25 55.	1 34.	4.8		
26 55.5	33.5	0.6		
27 56.5	27.5	0.4		
28 54.	1 25.	3.9		
30 24.5	2 55.5	16.8		
19 31 34.	4 05.	32.7		
		13.45		
				8)646 29 00
				80 48 37.5
				40 24 18.7
				56.4
				40 23 22.3
				11.8
				40 23 34.1

App. lat. = l	<i>o ' "</i>			<i>h. m. s.</i>	
Dec.	= 46 40 40	cos 9.83648	Chron. correction	1 12 35.8	Semi-diam.
a	= 2 55 48.3	cos 9.99943	* ΔR	18 14 53.2	Refraction 56".4
	= 40 23 20	cos 0.11824		19 27 29.0	Parallax
	.879	9.94415			

Determination of the latitude by observed double altitudes of Polaris off the meridian.

Station, Camp Baker, Montana.—Date, August 5, 1875.—Ref. Circle, Gambay & Son, 212.—Chronometer, Bond & Son, 202.—Observer, Wood.—
Computer, Wood.—Bar., 25th.30.—Ther., 53°.

Observed double altitudes.			Corresponding times.					
o	'	"	<i>h.</i>	<i>m.</i>	<i>s.</i>			
			19	01	49.5	log cos <i>p</i>	=	9.5388061
			02	41.5		log Δ	=	3.6893977
			03	07.5				
			03	53.5		log Δ cos <i>p</i>	=	3.2282038
			04	24.5			=	1691".2
			05	07.				
			05	54.		1st term	=	28 11.2
			06	32.		Alt. = <i>A</i>	=	46 11 53.7
204	13	30	07	00.		2d term	=	53.2
720	00	00	19	07	45.	Latitude	=	46 40 58.1
10) 924	13	30	19	04	49.45			
	92	25 21						
	46	12 40.5						
		46.9						
	46	11 53.7						

Refraction	46".8
Chron. correction	1 ^h 12 ^m 35 ^s .8
Dec.	88° 38' 29"
Δ	4891"
At Polaris	<i>h.</i> <i>m.</i> <i>s.</i>
Sid. time at mean noon at this station	1 13 08.76
Sid. interval from mean time of culmination	
Retardation of mean on sidereal time	
Mean time of culmination of star	
Error of chron. at time of observation	1 12 35.8
Time by chron. of culmination	2 25 44.56
Clock-time of observation	19 04 49.45
Hour-angle, <i>p</i> , in mean time	7 20 55.1
Sidereal equivalents in arc	110° 13' 47"
<i>p</i> in arc	

RECONNAISSANCE FROM CARROLL, MONTANA,

Summary table of daily instrumental observations with deduced altitudes, latitude, and longitude of each camp, and of the Montana posts, distances traveled, &c.

Station.	Date.	Start.	Arrive.	Barometer.	Elevation.	Latitude.	Longitude.	Day's march.	Total distance.
	1875.	<i>h.</i>	<i>h.</i>	<i>Inches.</i>	<i>Feet.</i>	<i>° ' "</i>	<i>° ' "</i>	<i>Miles.</i>	<i>Miles.</i>
Carroll.....	July 13	9.00 a. m.	.....	27.50	2,247	47 34 48	108 24 00	.....	.....
Little Crooked Creek.....	July 13	.....	1.30 p. m.	26.80	2,923	47 30 01	108 34 30	13	13
Crooked Creek.....	July 16	8.00 a. m.	10.00 a. m.	26.95	2,776	47 28 00	108 41 30	6	19
Box Elder Creek.....	July 18	7.00 a. m.	2.30 p. m.	26.28	3,437	47 20 43	109 02 00	19.5	38.5
Camp Lewis.....	July 25	6.00 a. m.	5.00 p. m.	25.83	3,890	47 03 47	109 26 30	36	74.5
Ross's Fork.....	July 26	7.30 a. m.	4.30 p. m.	25.54	4,186	46 47 03	109 44 00	27	101.5
Haymaker's Creek.....	July 27	7.00 a. m.	4.20 p. m.	25.07	4,673	46 30 00	110 06 40	29	130.5
North Fork Musselshell.....	July 28	7.30 a. m.	2.00 p. m.	24.70	5,063	46 33 13	110 28 30	19.25	149.75
Brewer's Springs.....	July 29	7.45 a. m.	4.00 p. m.	24.80	4,957	46 32 50	110 55 40	27	176.75
Camp Baker.....	July 30	8.30 a. m.	1.15 p. m.	25.20	4,538	46 40 44	111 11 00	16.75	193.5
Moss Agate Springs.....	Aug. 7	8.00 a. m.	5.00 p. m.	24.66	5,106	46 23 40	110 53 30	27	220.5
Twenty-five Yard Creek.....	Aug. 8	6.30 a. m.	5.30 p. m.	24.58	5,191	46 00 05	110 48 40	32	252.5
Fort Ellis.....	Aug. 9	6.15 a. m.	5.00 p. m.	25.00	4,747	45 40 15	110 59 04	28.75	281.25
Drane's Dam.....	Aug. 10	8.00 p. m.	8.45 p. m.	.....	.....	.....	.....	1.5	282.75
Boteler's Ranch.....	Aug. 11	6.30 a. m.	7.30 p. m.	24.88	4,873	.....	.....	33.25	316
Rocky Cañon.....	Aug. 12	6.30 a. m.	12.30 p. m.	24.80	4,958	.....	.....	15.5	331.5
Mammoth Springs.....	Aug. 13	7.45 a. m.	6.40 p. m.	23.73	6,114	.....	.....	18	349.5
Meadow Brook.....	Aug. 15	8.20 a. m.	3.00 p. m.	23.80	6,037	.....	.....	15	364.5
Cascade Creek.....	Aug. 16	8.40 a. m.	5.00 p. m.	22.28	7,767	44 43 40	.....	19.5	384
Mud Volcano.....	Aug. 18	8.20 a. m.	11.45 a. m.	22.40	7,626	44 37 17	.....	11	395
Yellowstone Lake and return.....	Aug. 19	9.30 a. m.	2.30 p. m.	.....	.....	.....	.....	16	411
Lower Geyser Basin.....	Aug. 20	8.30 a. m.	5.00 p. m.	22.73	7,238	.....	.....	26	437
Upper Geyser Basin.....	Aug. 21	1.10 p. m.	4.20 p. m.	22.64	7,347	44 27 40	.....	9	446
Jay Creek.....	Aug. 24	8.40 a. m.	7.30 p. m.	22.40	7,626	.....	.....	40	486
Meadow Brook.....	Aug. 25	8.00 a. m.	3.50 p. m.	.....	.....	.....	.....	23	509
Mammoth Springs.....	Aug. 26	7.50 a. m.	12.30 p. m.	.....	.....	.....	.....	15	524
Rocky Cañon.....	Aug. 27	12.30 p. m.	5.30 p. m.	.....	.....	.....	.....	18	542
Boteler's Ranch.....	Aug. 28	8.30 a. m.	12.30 p. m.	.....	.....	.....	.....	15	557
Sprague's Ranch.....	Aug. 29	8.50 a. m.	1.50 p. m.	.....	.....	.....	.....	16.5	573.5
Fort Ellis.....	Aug. 30	9.15 a. m.	1.50 p. m.	.....	.....	.....	.....	18.5	592
Bridger Creek.....	Sept. 2	3.00 p. m.	7.50 p. m.	.....	.....	.....	.....	6	598
Bridger Creek.....	Sept. 3	10.30 a. m.	4.00 p. m.	24.28	5,513	45 45 27	110 53 45	4	602
Bridger Pass.....	Sept. 4	8.20 a. m.	6.00 p. m.	23.70	6,147	45 53 40	110 53 30	10.25	612.25
Cottonwood Creek.....	Sept. 5	1.10 p. m.	7.00 p. m.	24.37	5,416	46 05 30	110 45 15	16	628.25
Deep Creek.....	Sept. 6	6.45 a. m.	5.30 p. m.	24.25	5,545	46 20 12	110 45 30	16.5	644.75
South Fork of Musselshell.....	Sept. 7	7.30 a. m.	4.00 p. m.	24.61	5,160	46 26 08	110 24 50	21.75	666.25
Hopley's Hole.....	Sept. 8	7.00 a. m.	6.15 p. m.	24.86	4,894	.....	.....	27.25	693.5
Buffalo Creek.....	Sept. 9	6.30 a. m.	1.30 p. m.	25.37	4,360	.....	.....	24	717.5
Camp Lewis.....	Sept. 10	6.45 a. m.	1.45 p. m.	25.83	3,890	.....	.....	21.5	739
Arnell's Creek.....	Sept. 11	6.30 a. m.	3.30 p. m.	25.90	3,830	47 19 12	109 12 00	26	765
Dog Creek.....	Sept. 12	7.30 a. m.	3.45 p. m.	26.05	3,668	47 25 10	109 20 30	16.25	781.25
Judith River.....	Sept. 13	7.00 a. m.	7.30 p. m.	27.40	2,343	47 41 30	109 39 30	28	809.25
Near Dog Creek.....	Sept. 16	6.30 a. m.	3.30 p. m.	26.50	3,220	47 31 17	109 27 30	17.5	826.75
Arnell's Creek.....	Sept. 17	6.30 a. m.	4.30 p. m.	.....	.....	.....	.....	23	849.75
Crooked Creek.....	Sept. 18	7.00 a. m.	4.45 p. m.	.....	.....	.....	.....	26	875.75
Carroll.....	Sept. 19	7.30 a. m.	2.15 p. m.	.....	.....	.....	.....	22.5	898.25
Fort Shaw.....	.....	.....	.....	.....	.....	47 30 33	111 48 19.5	.....	.....
Fort Benton.....	.....	.....	.....	.....	.....	47 49 36	110 39 48	.....	.....

Distances on the Missouri River from Bismarck to Benton, from a survey by Lieut. F. V. Greene, United States Engineers, under direction of Capt. W. J. Twining, Corps of Engineers.

From Bis- marck	To—	From Fort Benton.
<i>Miles.</i>		<i>Miles.</i>
805.4	Fort Benton	
787.7	Marias River	17.7
764.9	Little Sandy River	40.5
756.4	Citadel Rock	49
745.9	Cathedral Rock	59.5
743.4	Hole in the Wall	62
731.4	Arrow River	74
725.3	Drowned Man's Rapids	80.1
723.1	Old Camp Cook	82.3
722.4	Judith River	83
718.8	Holmes Rapids	86.6
707.6	Dauphin Rapids	87.8
693.7	Lone Pine Rapids	111.7
689.6	Sturgeon Island	115.8
681.9	Cow Island	123.5
671.4	Grand Island	134
665.3	Two Calf Island	140.1
657.8	Emile or Harriett Island	147.6
647.9	Little Rock Creek	157.5
638.9	Carroll	166.5
621.7	Beauchamp's Creek	183.7
619.4	Boyd's Island	186
600.9	Musselshell River	204.5
496.2	Fort Peck	319.2
408.6	Milk River	336.8
453.4	Porcupine Creek	352
373.4	Frenchmen's Point	432
355.8	Big Muddy River	449.6
321.9	Little Muddy River	483.5
309.4	Fort Union	496
305	Yellowstone River	500.4
302.9	Fort Buford	502.5
267.8	Muddy River	537.6
205	White Earth River	600.4
186.4	Little Knife River	619
131.6	Little Missouri	673.8
108.4	Fort Berthold	697
84	Fort Stevenson	721.4
60.4	Big Knife River	745
52.5	Fort Clark	752.9
.....	Bismarck	805.4

REPORT OF A RECONNAISSANCE OF JUDITH BASIN, AND OF A TRIP FROM CARROLL TO FORT ELLIS, VIA YELLOWSTONE RIVER.

BY LIEUT. R. E. THOMPSON.

FORT STEVENSON, DAK., *March 8, 1876.*

SIR: I have the honor to forward herewith a report of the reconnaissance of the Judith Basin, made during the past summer, in accordance with your orders, and an account of my subsequent return from Carroll, Mont., to Fort Ellis, by way of the Yellowstone River.

The trip to the Judith River, which was laid out as part of the summer's work, on condition that it could be completed before the close of navigation on the Upper Missouri, was ordered from the camp on Armell's Creek, September 11. Its object was the examination of the country in the vicinity of the Judith, with regard to its topographical features, to accurately locate its position, but more particularly to afford an opportunity for a thorough search for fossil remains in the cut banks of its valley, which offer so extensive an exposure. The party consisted of a sergeant and one private of the Engineer Battalion, charged with running the trail by compass and odometer; a detachment of a sergeant and seven privates of the Second Cavalry as escort; and Reynolds as guide.

Mr. G. B. Grinnell and Mr. Ludlow accompanied the party; the former interested in the paleontology and zoology of the country. Sextant-observations were made by Mr. W. H. Wood whenever practicable.

Including myself, the party numbered fifteen men, all mounted, save the teamster, the sergeant in charge of the odometer-cart, and the man charged with the care of the chronometers.

On the morning of September 12, the party was put *en route* across a stretch of rolling prairie country. The general course was toward Square Butte, a landmark in the vicinity of Benton, considerably west of the point to be reached; but it was deemed advisable, from lack of knowledge of the country, and from the broken appearance to our right, to make the divide between Dog Creek and the Judith, and to follow this up till opportunity offered to descend to the valley of the latter stream near its mouth. The headwaters of Dog Creek were reached in the afternoon. Here I was joined by Reed, who had volunteered his services as guide. Camped at a pool near this creek.

In the morning (September 13), a course more to the north was taken, bearing nearly on Bear's Paw Mountains. The divide was kept from necessity, either valley being impassable for wagon. Shortly after leaving camp, the broken character of the Judith Bad Lands began to appear to our left and front.

For twenty miles back from the mouth of the stream, the country immediately tributary to it is washed and cut into the wildest and most rugged shapes. The soil is of that clayey character capable of supporting itself at steep inclines; and where ordinarily the drainage would be conducted in simple valleys or natural depressions, here gulches and ravines, with precipitous sides, are formed by the flow of the water. The worst of these were avoided, and to within ten miles of the mouth of the Judith our path was over a country such that a heavily-loaded wagon-train could have been conducted with but little difficulty.

The Judith and Dog Creeks from their sources converge gradually, and, at their junction with the Missouri, are but three miles apart. The valley of Dog Creek is broken in a manner similar to that of the Judith; and, back ten miles from their mouths, this erosion, from long-continued action of water, has gone to such extent that the summit of the divide between these two streams is a simple backbone of a few feet in width, and the passage of this ridge with a single wagon, lightly loaded and conducted with care, nearly entailed the loss of the team. This difficult piece of road lasted but a few hundred yards. For six miles farther on the valleys keep apart, and give a good stretch of prairie.

A descent into the valley of the Judith was made at a point four miles from its mouth. Camped on the river; abundance of wood; grazing poor.

The Judith is a swift-running stream, from 60 to 80 feet in width, and has a depth of water varying from 2 to 4 feet. Its sources in the Judith Mountains are clear, cold springs, but the character of the water changes completely in its course to the Missouri. Its temperature is very much increased, and a considerable amount of earthy matter is taken up and held in suspension. Though all its upper branches are plentifully stocked with trout, none of these fish were taken in the main stream. Its valley proper, from bluff to bluff, is about a mile wide, well timbered with a young growth of cottonwood. Scrub pines and cedars are sparsely scattered over the highlands, principally on the sides and at the heads of ravines. From the rate at which the wood is now being taken out for the supply of steamboats, the whole will be exhausted before many years.

September 14, moved camp half a mile down stream for better grazing; visited Fort Claggett, a small Indian trading-post on the Missouri, a short distance above the Judith. It consists of two log buildings facing each other; their ends joined by a stockade, with a small flanking arrangement at the alternate angles. A few Indians were seen about; their tepees standing near the fort.

From the ruins of old Camp Cooke, in the west angle between the Judith and Missouri, the plan of the post can be distinctly traced; some of the adobe walls still withstanding the effects of the weather.

The 15th and 16th were consumed in a vigorous search for fossils by nearly all the party. Observations were made by Mr. Wood.

On the night of the 16th, a courier arrived from Carroll, with orders from you for the return of the party. Preparations were made accordingly. As it is highly probable that a more lengthened search in this vicinity than our time had allowed would be richly rewarded, and, in order to afford every facility for the improvement of the time that could be gained, a mackinaw was procured, by which Mr. Grinnell, at whose disposal it was placed, with Messrs. Ludlow and Reynolds, was enabled to remain somewhat longer upon the ground, and then make Carroll by way of the Missouri as soon as the overland party.

The return trip began on the 17th. My old trail was necessarily taken for part of the way back; but, as soon as opportunity offered, a course to the east of it was taken; but little was gained by this, however, for from the nature of the ground I was compelled to pass near the old camp on Armell's Creek.

But little game was seen on the Judith. The Indians, as well as white men in that vicinity, kill for hides alone for purposes of trade. The consequence is very apparent. But three or four herds of buffalo and a few antelope were seen there; antelope becoming more plentiful as we left the river behind us.

Carroll was reached the afternoon of the 20th; the party by boat making the landing soon after.

This trip demonstrated the practicability of a wagon-road through the Judith Basin to the Missouri; though for general use a considerable amount of work would first needs be done.

The trail was carefully kept; the principal topographical features being sketched in. The data for the plotting of the course and the astronomical notes are already in your hands.

Every facility was afforded Mr. Grinnell in his collection of fossils. It is to be regretted that longer time could not have been taken in this work.

After the departure of the main party from Carroll for the East, it devolved upon me to conduct the transportation back to Ellis.

The party under my charge consisted of but two sergeants and ten privates of the Second

Cavalry, and it was my intention to follow the road previously passed over by the party; but on my arrival at the forks of the Musselshell River, I found a company of the Second Cavalry, commanded by Lient. L. H. Jerome, under orders to scout the country east of the Crazy Mountains as far as the Yellowstone, and thence to return to Fort Ellis by way of that river.

Through the courtesy of Lieutenant Jerome, I was enabled to avail myself of the opportunity (which the small force at my disposal rendered it imprudent to attempt) to strike the Yellowstone at Big Timber Creek, a point within about seventy miles of that to which General Forsyth had ascended with his expedition in the spring.

Camp at the forks of the Musselshell was struck on the 28th of September, crossed to the south side of the Musselshell a mile below the forks, followed the general course of this stream for about four miles to the Little Elk—a well-wooded stream, crossed from this creek to the Big Elk (seven miles) in a course a little east of south, passed this stream, and three-quarters of a mile farther on a branch of the same. About eight miles more of travel brought us to the Porcupine (or American Fork). Here camped.

Throughout this day's march, an exceedingly large number of antelope were observed, and at our camp on the Porcupine the woods and underbrush were alive with deer, showing in a very marked manner the absence of the skin-hunter.

September 29.—Traveled seven miles to Summit Creek; four miles farther on crossed the Sweet Grass, a tributary to the Yellowstone. It is fed by springs and melted snow from Crazy Mountain, and flows a volume of water nearly equaling that of the Musselshell.

Beyond this, several small streams were passed: Beaver Creek, standing in pools at this season, two miles; a branch of same, half a mile; three miles farther on, Williamson's Creek, and a mile from this, Burnt Creek, all emptying into the Sweet Grass.

The first crossing of Big Timber Creek was at three miles; we recrossed half a mile beyond, and camped on left bank. This stream is about 20 feet wide, clear and cold. The valley is *very* heavily timbered.

On the department maps, several small streams are noted as running into Big Timber from the north. There are no streams of any moment after passing Burnt Creek going south on this trail.

October 1.—Traveled down left bank of Big Timber for about five miles; crossed within half a mile of its mouth. Here observed indications of Indians, probably Crows.

Two large tripods, 20 feet or more in height, had been erected, and from the legs of these were suspended hundreds of moccasins, some of them beautifully beaded. It was remarkable that none of these moccasins were more than 5 inches in length; the most of them averaging about 3 inches; probably some offering, or medicine. Traveled up Yellowstone on its left bank. Little Timber about four miles and a half from Big Timber, about a third of the size of the latter; well wooded. The country between these two streams is very poor, almost no grazing; sage-brush being the main production. Half a mile farther on crossed a branch of Little Timber; the two unite about three hundred yards from the Yellowstone. Three miles beyond, Cherry Creek. In succession, we passed Duck Creek three miles on, Hot Spring Creek three miles beyond, and Cold Spring Creek a mile beyond that. Went into camp on the Yellowstone near the latter.

October 2.—General course still along Yellowstone. Crossed Yellowstone ten miles from camp at a point nearly opposite old Crow agency. The ford was very circuitous, ranging back and forth along the bars to avoid deep water. At this season, the greatest depth on this ford brings the water nearly to the wagon-body.

The old Crow agency, recently abandoned, is at the foot of the Yellowstone Mountains, opposite to, and about four miles from, the mouth of Shield's River. It consists of a collection of rude buildings, principally adobe. Recrossed the Yellowstone about five miles above the agency. There are two fords equally good, one above and one below "Benson's Ferry." Formerly, the passage of the stream at high water was made by a ferry-boat conducted by means of a cable stretched across the river. At the time of my crossing, the ferry was not in existence. Its place is marked by two stones on the left bank. Camped two miles below, just opposite one of the highest points of the Yellowstone Mountains, called Medicine Peak.

October 3.—After leaving camp, crossed Fleshman's Creek about eight miles from Shield's River.

Half a mile beyond is a small stream, which I followed up for about twelve miles, then pulled over a high divide; at this point the only difficult road was encountered. Across the divide, the head of the Middle Fork of the Gallatin River was struck, and a general course with that of the stream was followed to Fort Ellis.

In the progress up the Yellowstone River, a very noticeable feature presented itself; the change of the character of the country adjacent to it. Throughout its whole length on the lower stream, the elevations on either side never attain to more than the dignity of "buttes." But from the moment of passing Crazy Mountain, the scenery of the river becomes more in keeping with the grandeur to which it attains above.

Very respectfully, your obedient servant,

R. E. THOMPSON,
Second Lieutenant Sixth Infantry.

Capt. WILLIAM LUDLOW,
Corps of Engineers, Saint Paul, Minn.